LOOKING BACK AND MOVING FORWARD: A MIXED METHODS STUDY OF ELEMENTARY SCIENCE TEACHER PREPARATION

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Abstract: This study sought to understand how science learning experiences, and their potential influence, had on preservice elementary teachers' self-efficacy and perceptions of science teaching and learning at the beginning of their science methods course. Following an explanatory sequential mixed methods design, this study first involved the collection of quantitative data and then the collection of more in-depth qualitative data. In the first phase, the quantitative data included the Draw-a-Science-Teacher-Test Checklist (DASTT-C) and the Science Teaching Efficacy Belief Instrument (STEBI-B) of preservice elementary teachers (n = 69). Findings from this phase indicated preservice elementary teachers had a higher level of belief in their abilities to teach science (PSTE subscale) than to affect student outcomes in science (STOE subscale). However, the STOE was not found to be a reliable measure for this group of preservice elementary teachers and was not included in any further analysis. Findings from the DASTT-C images indicated the majority of these drawings could not be classified as student-centered. In the second phase of this study, the researcher explored selected science autobiographies written by these same preservice elementary teachers (n = 19), based on extremely high or low scores on the PSTE subscale and DASTT-C. Analysis of the science autobiographies revealed commonalities and differences. Commonalities included (a) the difficulty in remembering science from elementary school; (b) a mixture of positive and negative experiences in secondary school and college science classes; (c) the descriptions of good science days and good science teachers; and (d) the descriptions of bad science days and bad science teachers. Differences included (a) the people who influenced their attitudes toward science; (b) the types of experiences, when remembered, from elementary school; and (c) visions of their future classrooms. Based on these findings, these preservice elementary teachers used their past experiences with science as a foundation for how they perceived science and its instruction in the elementary classroom. Overall, it appears preservice elementary teachers have a desire to make the elementary experience a positive one for their future students.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Preservice elementary teachers come to their science methods course with perceptions of science and its instruction in the elementary classroom. These perceptions include not only what science instruction should look like, but also how they plan to implement science in their future classrooms (Gustafson & Rowell, 1995; Seung, Park, & Narayan, 2011; Thomas & Pedersen, 2003). It is important to become aware of these perceptions as they have the potential to influence the effect of the science methods course and what preservice elementary teachers take from the course.

Preservice elementary teachers often begin their science methods course with low to moderate science teaching, indicating they do not believe they have the abilities to teach science effectively (Bleicher & Lindgren, 2005; Bursal, 2012; Finson, 2001; Hechter, 2008; Morrell & Carroll, 2003; Tosun, 1994; Wagler, 2007; Watters & Ginns, 1995, 2000). When preservice elementary teachers have low to moderate perceptions of their abilities to teach science, modification of instruction within science methods courses can occur to address and raise these perceptions. While studies have shown that science methods courses can raise the perceptions of science teaching ability in preservice elementary teachers, we do not necessarily know how and when these perceptions originated (Bleicher & Lindgren, 2005; Bursal, 2012; Finson, 2001; Watters & Ginns, 2000).

One possible source of these perceptions is preservice elementary teachers' personal experiences with science. Science experiences can be quite different from person to person, yet most remember experiences from secondary school more often than those from elementary school (Ellsworth & Buss, 2000; Gauthier, 1994; Jesky-Smith, 2002; Sutton, Watson, Parke, & Thomson, 1993). Regardless of the number of experiences remembered by preservice elementary teachers, they typically describe their experiences from elementary school as being more positive than those at the secondary college levels (Bulunuz & Jarrett, 2010; Jarrett, 1999; Sutton et al., 1993).

Despite preservice elementary teachers' diverse experiences with science, most connect their positive or negative experiences with the instruction implemented by their K-16 teachers. Preservice elementary teachers link their positive experiences to hands-on activities that connect to the real world; whereas, negative experiences are linked with lecture or textbook-based instruction (Gauthier, 1994; Sutton et al., 1993; Talsma, 1997). In sum, many preservice elementary teachers come to their science methods course with various experiences in science, and these experiences are linked to their perceived abilities to teach science.

When prompted to visualize and discuss their perceptions of science teaching and learning, most preservice elementary teachers enter their science methods course with ideas reflecting stereotypical, teacher-centered classrooms, where the teacher is responsible for passing on scientific knowledge to students (Hancock & Gallard, 2004; Minogue, 2010;

Seung et al., 2011; Talsma, 2007; Ucar, 2011; Weber & Mitchell, 1996). Prior research has established that preservice elementary teachers have experiences with science and perceptions of how science should be taught in the elementary classroom (Gustafson & Rowell, 1995; Seung, Park, & Narayan, 2011; Thomas & Pedersen, 2003). In addition, prior research has stated preservice elementary teachers have perceptions of their abilities to teach science effectively (Bleicher & Lindgren, 2005; Bursal, 2012; Finson, 2001; Hechter, 2008; Morrell & Carroll, 2003; Tosun, 1994; Wagler, 2007; Watters & Ginns, 1995, 2000). What still needs to be examined is the role these experiences play in preservice elementary teachers' expectations of themselves as science teachers.

Purpose of the Study

This study sought to understand how science learning experiences, and their potential influence, had on preservice elementary teachers' self-efficacy and perceptions of science teaching and learning at the beginning of their science methods course. Following an explanatory sequential mixed methods design (Creswell & Plano-Clark, 2011), this study first involved the collection of quantitative data and then the collection of more in-depth qualitative data. The quantitative data included the Draw-a-Science-Teacher-Test Checklist (DASTT-C) (Thomas, Pedersen, & Finson, 2001) and the Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990). This quantitative data was collected from preservice elementary teachers at the beginning of their science methods course. In the second phase of this study, the researcher explored science experiences of these same preservice elementary teachers through analysis of science autobiographies written during the first week of the science methods course.

Research Questions

The central research question guiding this study was: What is the relationship between preservice elementary teachers' perceived science teaching ability, past science experiences, and perceptions of science teaching and learning?

The specific sub-questions were:

1) What are the personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) beliefs of preservice elementary teachers as measured by the Science Teaching Efficacy Belief Instrument (STEBI-B)?
2) How do preservice elementary teachers depict themselves as science teachers as measured by the Draw-a-Science-Teacher-Test Checklist (DASTT-C)?
3) What is the relationship between the DASTT-C scores, PSTE subscale scores and STOE subscale scores for preservice elementary teachers? and
4) How do preservice elementary teachers' science autobiographies explain their scores on the DASTT-C, PSTE subscale, and STOE subscale?

Terms and Definitions

The science autobiographies are papers written by preservice elementary teachers. Within the science autobiographies, preservice elementary teachers described their experiences with science from elementary school through college and any influential people or events on their current attitudes toward science. This paper was a course assignment completed within the first week of the science methods course. Students responded to specific prompts in a three to four page narrative paper.

The Draw-a-Science-Teacher-Test Checklist (DASTT-C) is an instrument developed by Thomas et al. (2001) that prompts preservice elementary teachers to draw themselves as a science teacher at work and write a narrative describing what the teacher and students are doing within the image. Images were analyzed for specific characteristics relating to the teacher, the students, and the classroom environment.

Formal science experiences are those science experiences which occurred inside a science classroom in grades K-16.

Informal science experiences are those science experiences which occurred outside of a science classroom (e.g., camping, visiting zoos and/or museums with parents).

The Science Teaching Efficacy Belief Instrument (STEBI-B) is an instrument developed by Enochs and Riggs (1990) that measures preservice elementary teachers' perceived abilities to teach science effectively in their future classrooms. Within the STEBI-B are two subscales: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE).

The PSTE subscale measures perceived self-efficacy abilities to teach science in the future.

The STOE subscale measures perceived abilities to affect student outcome and achievement in science.

Self-efficacy is peoples' belief in their ability to carry out the necessary steps to affect change in particular situations (Gibson & Dembo, 1984; Pajares, 1996).

Theoretical Perspective

Bandura (1991) described social cognitive theory as a means for explaining human behavior; through monitoring and self-influence, people develop their behavior in situations. As individuals engage in their social experiences, they take in, process information, and develop a mental model of their environment. They then relate these mental models to outcome expectancies, self-efficacy, and self-reactions. These mental models are thought to influence how individuals interact with their current environment and the types of environments they wish to seek in the future (Thomas et al., 2001).

Delimitations

This study was delimited to elementary education majors at a large, land grant university in the Midwestern United States who were enrolled in the fall 2012 semester of an elementary science methods course. Further, this study was delimited to examinations of teachers' self-efficacy when teaching science, their images of themselves as science teachers, and their personal memories of experiences with science.

Limitations

The study was limited to a convenient sampling wherein the researcher cannot say with confidence the sample will be representative of the population (Creswell, 2008). Because of this limitation, research results are only applicable to these specific preservice elementary teachers. Another limitation of this study was that due to the nature of qualitative research the data obtained in the study may be subject to different interpretations by other researchers, in that the researcher's own experiences have the potential to influence her interpretation. As a former classroom teacher, the researcher may have her own understanding and views of the teaching and learning of science that may differ from those of the participants.

Significance of the Study

This study may be significant in contributing to the development of science methods courses within elementary education programs. The types of experiences preservice elementary teachers had and the potential influence on their current perceptions of science teaching and learning can lead to improved course instruction in the science methods course. Preservice elementary teachers can be provided with opportunities to expand their perceptions of science teaching and learning within their science methods course through the presentation of a variety of teaching methodologies.

Additionally, this study may yield new insights due to the mixed methods design. Utilizing multiple forms of data collection and analysis, this study can provide various viewpoints from which to examine the topic of preservice elementary teachers' early perceptions of science teaching and learning. By utilizing the STEBI-B and DASTT-C in connection with science autobiographies, the researcher can provide a more complete picture of the relationship between self-efficacy, images of science teaching, and past science experiences of preservice elementary teachers.

Summary

This chapter outlined the purpose and significance of the study, including the central research question and sub-questions. In addition, this chapter presented important terms and their definitions, as well as the theoretical perspective, delimitations and limitations specific to the study. The next chapter will present and discuss literature relevant to the central research question and sub-questions, and the theoretical perspective that guided the study.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The purpose of this chapter is to review research that is relevant to preservice elementary teachers' perceptions of science teaching and learning as viewed through social cognitive theory. Preservice elementary teachers' beliefs in their perceived abilities to teach science and their perceptions of science teaching and learning connect to each other as well as to their experiences in science. The following review of selected studies highlights findings most descriptive of this relationship. The sections of this chapter are as follows: social cognitive theory; self-efficacy; science experiences; perceptions of science teaching and learning; and relationship between self-efficacy, experience, and perceptions.

Social Cognitive Theory

Bandura (1991) described social cognitive theory as a means for explaining human behavior; people develop their behavior in situations through monitoring and self-influence. As described by Grusec (1992), Bandura's social cognitive theory recognizes the interaction and influence of three separate factors: 1) individuals, 2) their environment, and 3) their behavior. As individuals engage in their social experiences, they take in, process information, and develop a mental model of their environment. Then they relate these mental models to outcome expectancies (goals of a situation), self-efficacy (perceived abilities), and self-reactions (behavior). These mental models, as developed by individuals, may influence how they interact with their current environment and the types of environments they wish to seek in the future.

Bandura (1991) described the interaction of these three factors by stating that people, based on their beliefs in their abilities, will set goals for themselves, expect certain outcomes, and plan ways in which to produce outcomes they desire. In addition to setting goals and selecting a plan of action to produce desired outcomes, peoples' belief in their efficacy (ability to cause a change) determines how long they persist in an environment that presents obstacles to goal achievement. People who believe in their abilities will find ways around obstacles to achieve desired goals. Stated another way, personal self-efficacy beliefs determine a person's motivation in particular environments, perceived effect of that environment, and courses of action within that environment (Bandura, 1989).

Self-Efficacy

Pajares (1996) described self-efficacy as "individuals' perceived capabilities to attain designated types of performances and achieve specific results" (p. 546). Essentially, self-efficacy refers to peoples' belief in their abilities to take the necessary steps to obtain desired outcomes in a particular situation (Gibson & Dembo, 1984). When people have high self-efficacy, they will see themselves as having a greater impact on the outcomes of a situation and will continue to pursue that situation until they achieve their desired outcomes. However, if people have low self-efficacy, they may see a situation as beyond their abilities (which makes desired outcomes unlikely) and change their course of action to avoid the situation (Pajares, 1996).

Bandura (1977) identified four sources that influence self-efficacy: (a) performance accomplishments – personal success and mastery of experiences; (b) vicarious experiences – watching others have success in a threatening situation; (c) verbal persuasions – others indicating a person can have success in a situation; and (d) physiological states – emotional arousal produced by a situation. According to Bandura (1977), a person will typically have high self-efficacy with one or more of the previously mentioned sources. Connecting these four sources to elementary education, preservice elementary teachers will most likely demonstrate high self-efficacy if one or more of the following occur: (a) they have had success in science and/or science teaching; (b) they have seen others have success in difficult science situations; (c) they have been told they are good at science and/or science teaching; or (d) they do not experience stress or anxiety in science and/or science teaching.

Teacher Self-Efficacy

The self-efficacy of teachers relates to their beliefs in personal abilities to affect student learning and fulfill the responsibilities of teaching (Ashton, Buhr, & Crocker, 1984). Teachers' self-efficacy determines their behavior in the classroom (Tschannen-Moran & Hoy, 2001). These behaviors include how much time teachers apply to planning and instruction, as well as the goals they make for themselves and students. If teachers have low self-efficacy in their teaching abilities (especially within a certain content area) then they may create an environment in which they can avoid those particular content areas. On the other hand, teachers with high self-efficacy create environments in which students are engaged in classes and can experience success and/or master their experiences (Bandura, 1993).

Teachers with low self-efficacy may not believe in their ability to help students have success in classroom activities. For example, teachers with low self-efficacy influence classroom instruction by (a) providing students with answers instead of using questioning techniques to guide them and (b) not providing positive verbal reinforcement for students (Gibson & Dembo, 1984). Teachers with low self-efficacy may avoid teaching concepts they struggle with or not encourage students when teaching difficult concepts. Positive verbal reinforcement is one of the keys to developing self-efficacy (Bandura, 1977). When teachers with low self-efficacy do not provide positive verbal reinforcement, students may develop low self-efficacy; resulting in the perpetuation of low self-efficacy.

The effect of a teacher's self-efficacy on classroom instruction also applies to specific content areas. If teachers demonstrate low self-efficacy in relation to the teaching of science, they will not pursue teaching science content. Also, if teachers have low self-efficacy in science, they will not invest a considerable amount of time in planning for and implementing science instruction (Enochs & Riggs, 1990).

Measuring Teacher Self-Efficacy

The Rand Corporation developed one of the earliest studies on self-efficacy in 1976. The instrument used in the study measured teaching self-efficacy by the level of agreement teachers indicated on two items (Armor et al., 1976). The summation of the two items determined the level of control the teacher felt they had in relation to student motivation and learning. Other researchers questioned the reliability of a two-item measure and its accuracy at providing a complete picture of teacher self-efficacy. Soon, other researchers developed the Teacher Locus of Control Scale (Rose & Medway, 1981) and the Responsibility for Student Achievement (RSA) scale (Guskey, 1981).

The Teacher Locus of Control (TLC) Scale (Rose & Medway, 1981) utilized 28 forced response items that assessed elementary teachers' beliefs in their abilities to control events in their classroom. Half of the 28 items referenced situations where students were successful and the other items referenced failure situations. Teachers who scored high on the TLC were more likely to accept responsibilities of events that took place within the classroom (Rose & Medway, 1981).

Similar to the TLC, the RSA sought to measure how much responsibility the teacher accepted for general student outcomes, student success, and student failure (Guskey, 1981). The RSA asked teachers to distribute points between alternative explanations for 28 items. In a study utilizing a modified version of the RSA, which contained 30 items as opposed to 28, Guskey (1988) found that elementary and secondary teachers both held positive attitudes toward teaching and felt confident in their abilities to teach.

The Webb scale, developed by Aston, Olejnik, Crocker, and McAuliffe (as cited in Tschannen-Moran & Hoy, 2001; Tschannen-Moran, Hoy, & Hoy, 1998), measured teacher self-efficacy while limiting the survey options. This instrument consisted of seven items that required teachers to select between two differing options relating to a particular classroom situation. However, this instrument was not widely accepted since few studies utilized the instrument beyond the development of the scale (Tschannen-Moran & Hoy, 2001; Tschannen-Moran, Hoy, & Hoy, 1998).

Ashton, Buhr, and Crocker (1984) developed a series of 50 vignettes describing specific teaching situations in an effort to measure the idea that teacher self-efficacy is context specific. These vignettes required teachers to determine how effective they would be in handling each situation. The results of this study indicated that teachers, based on information from students or stories shared from other teachers, measured their own effectiveness by comparing it to the performance of other teachers. This led Ashton et al. (1984) to recommend that increased self-efficacy could involve sharing thoughts with other teachers and observing each other teach, as opposed to basing self-efficacy on stories from others.

In an attempt to address Bandura's (1977) social cognitive theory, Gibson and Dembo (1984) developed the Teacher Efficacy Scale (TES) to determine self-efficacy and outcome expectancy levels held by teachers. The TES consisted of two factors: (1) the personal teaching efficacy factor and (2) teaching outcome expectancy. Gibson and Dembo (1984) found that teacher self-efficacy is multidimensional, meaning that teaching self-efficacy results from a combination of self-efficacy and outcome expectancy. Other researchers have modified the TES to apply its use to specific content areas, specifically science (Enochs & Riggs, 1990; Riggs, 1988).

Measuring Science Content-Specific Teaching Self-Efficacy

Riggs (1988) developed the Science Teaching Efficacy Belief Instrument (STEBI) to measure the self-efficacy of elementary science teachers as it relates to personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). The PSTE subscale measures teachers' beliefs in their abilities to teach science. The STOE subscale measures teachers' beliefs that students can learn science regardless of backgrounds or school environments.

Enochs and Riggs (1990) further modified the STEBI to measure preservice elementary teachers' perceived PSTE and STOE in their future classrooms, resulting in the STEBI-B. By focusing on preservice elementary science teachers, Enochs and Riggs (1990) expected that early detection of low self-efficacy could lead to early interventions and motivate science methods instructors to engage preservice elementary teachers in activities that would increase their self-efficacy in science teaching. Like the STEBI, the STEBI-B also consists of two subscales: (a) The PSTE subscale includes 13 items that measure preservice elementary teachers' beliefs in their perceived abilities to teach science in the future. (b) The STOE subscale consists of 10 items that measure preservice elementary teachers' beliefs in their perceived ability to affect change in students through the teaching of science. Items from both subscales are answered with a five-point Likert-scale response system (Enochs & Riggs, 1990).

Science Teaching Self-Efficacy of Preservice Elementary Teachers

Since the development of the STEBI-B (Enochs & Riggs, 1990), multiple studies have utilized this instrument to measure the self-efficacy of preservice elementary teachers as they relate to the effects of a science methods course. In these studies, the administration of the STEBI-B occurred at the beginning and end of a science methods course to measure a change in scores of the PSTE and STOE subscales (Bursal, 2012; Ginns, Tulip, Watters, & Lucas, 1995; Morrell & Carroll, 2003; Utley, Moseley, & Bryant, 2005; Watters & Ginns, 2000).

In the studies conducted by Morrell and Carroll (2003), Utley et al. (2005), Watters and Ginns (2000), and Bursal (2012), preservice elementary teachers' scores indicated significant increases on the PSTE subscale but not the STOE subscale. Conversely, Ginns et al. (1995) found a significant increase on the STOE subscale and not the PSTE subscale. On the other hand, in a study conducted by Hechter (2008), preservice elementary teachers completed the STEBI-B at the beginning and end of the science methods course, indicating a decrease on both the PSTE and STOE subscale scores. Based on these studies there are conflicting results regarding the effect of a science methods course on preservice elementary teachers' beliefs in their abilities to teach science effectively or to affect student outcomes in science. However, the majority of studies indicated an increase in the PSTE subscale due to participation in a science methods course, meaning the science methods course helped preservice elementary teachers increase their beliefs in their abilities to teach science (Bursal, 2012; Morrell & Carroll, 2003; Utley et al., 2005; Watters & Ginns, 2000).

In summary, preservice elementary teachers generally held lower personal science teaching self-efficacy and science teaching outcome expectancies at the beginning of their science methods course. However, there were conflicting results in describing the participation of preservice elementary teachers in a science methods course and the effects on their personal beliefs toward science teaching. Further studies can help us better understand the potential effects of science methods courses on personal beliefs that preservice elementary teachers have toward science teaching and learning.

Science Experiences

As stated previously, self-efficacy is influenced by four sources: (a) performance accomplishments; (b) vicarious experiences; (c) verbal persuasions; and (d) physiological states (Bandura, 1977). Throughout encounters with science, people can experience some or all of these sources of influence on self-efficacy. By examining the presence of these influential sources in past science experiences, one can better understand the development of self-efficacy. For example, in a study conducted by Bryan and Tippins (2005), preservice elementary teachers discussed one particular instance from their science experiences in which they indicated a personal dislike of science or fear related to science. Researchers found that preservice elementary teachers carried a dislike or fear of science for several years as a result of experiences in K-12 science classes (Bryan & Tippins, 2005). Van Zee and Roberts (2001) also found that preservice elementary teachers expressed increased anxiety towards the teaching of science that they linked to their negative experiences. Additionally, Koch (2010) argued that the success of science teachers relates to their experiences as science learners. Koch (2010) suggested teachers need to face their past science experiences and understand how negative experiences affect their present and future science teaching, only then can they address any fears or anxiety towards science teaching.

Formal Science Experiences

Formal science experiences refer to those experiences occurring within a science classroom. Traditionally, individuals' first formal science experience occurs in the elementary grades. Multiple studies have examined the types of experiences preservice elementary teachers had while in elementary school, and a common finding among these studies was the lack of science memories (Ellsworth & Buss, 2000; Gauthier, 1994; Jesky-Smith, 2002; Sutton et al., 1993). In studies utilizing autobiographies, Ellsworth and Buss (2000) reported that only 38% of 37 science autobiographies mentioned science experiences from grades K-6. Similarly, Gauthier (1994) reported science experiences in elementary school in only 46% of 80 autobiographies. Jesky-Smith (2002) utilized a questionnaire and found that 35% of 60 preservice elementary teachers could not remember science from elementary school. With questionnaires and interviews, Sutton et al. (1993) reported that only 8% of 62 preservice elementary teachers could remember science from their elementary school years.

Preservice elementary teachers who could remember their science experiences from elementary school were able to describe (a) the experience as positive or negative and (b) if the experience included hands-on activities that were fun and involved the students (Bulunuz & Jarrett, 2010; Jarrett, 1999; Steele, Brew, Rees, & Ibrahim-Khan, 2013). Jarrett (1999) found that 37% of 112 preservice elementary teachers had positive experiences in elementary science, whereas 63% felt their experiences were negative or they could not remember any science. Based on questionnaires, Bulunuz and Jarrett (2010) found that preservice elementary teachers had slightly above average enjoyment of science in elementary school if they described their experiences as fun, interesting, and hands-on. Based on surveys, Steele et al. (2013) found that 71% of 131 preservice elementary teachers enjoyed science in elementary school, especially when it involved hands-on activities. These studies indicated that preservice elementary teachers enjoyed their experiences from elementary schools when they could remember them and if those memories were of hands-on activities.

Some studies indicated that preservice elementary teachers' memories of their elementary school science experiences focused on the use of a textbook (Jesky-Smith, 2002; Sutton et al., 1993). For example, Jesky-Smith (2002) found that 42% of 60 preservice elementary teachers described science lessons which focused on the textbook or led by the teacher. Similarly, Sutton and colleagues (1993) found that 8% of 62 preservice elementary teachers could remember science in elementary school and three of these were memories consisting of textbooks and worksheets.

The number of experiences recalled by preservice elementary teachers from their secondary grade levels increased, when compared to the number of experiences recalled from elementary school (Bulunuz & Jarrett, 2010; Gauthier, 1994; Jarrett, 1999; Sutton et al., 1993). Gauthier (1994) reported an increase of recalled experiences from elementary to secondary school, with 47% of autobiographies recalling elementary science to 63% recalling secondary science. However, those recalled experiences were not always positive. As reported by Sutton et al. (1993) most of their 62 participants remembered science in the secondary levels as being difficult. Similarly, Bulunuz and Jarrett (2010) found that their participants lacked very positive science experiences in middle and high school. However, Jarrett (1999) reported mixed results regarding high school science experiences in that 32% of participants reported negative experiences, 31% of participants reported partially positive experiences, and 37% of participants reported enthusiastic experiences (Jarrett, 1999). Likewise, Steele et al. (2013) found that 29% of preservice elementary teachers indicated a lack of enjoyment of science as they progressed through school, yet 15% indicated an increase in enjoyment. Based on these studies, preservice elementary teachers remembered more science from secondary than elementary school, yet elementary was more often a more positive experience.

Several studies discussed preservice elementary teachers' experiences during college science courses (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000; Sutton et al., 1993). Overall, preservice elementary teachers' negative experiences continued to increase as they progressed into college; so much that they began to dread certain courses (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000). In the studies by Bulunuz and Jarrett (2010) and Sutton et al. (1993), preservice elementary teachers indicated the specific courses taken in college and their perceptions of those courses. Bulunuz and Jarrett (2010) found that the top science courses in college were biology, geology, astronomy and physics. Sutton et al. (1993) also found that biology was a top choice for preservice elementary teachers, but it was the course that received the most criticism due to the typically large class size and large amounts of material covered. Based on these studies, preservice elementary teachers' negative experiences continue from secondary school into college, yet there are also indications of positive experiences with certain courses.

Overall, previous research suggests preservice elementary teachers remembered science from secondary school and college more often than elementary school. One possible reason for this recollection of more secondary and college experiences is because preservice elementary teachers are older during the secondary and college levels (and these grade levels occurred closer to their teacher preparation programs). Reasons for a lack of memories from elementary school could be because these preservice elementary teachers did not have science in their elementary classroom or the science instruction was simply not memorable. Yet, when remembered, the experiences from elementary school were typically more positive than the experiences from secondary school or college.

Informal Science Experiences

Informal science experiences refer to those experiences occurring outside of the science classroom (e.g., camping and/or visiting museums and zoos with parents). Some studies asked preservice elementary teachers to describe experiences outside of the science classroom (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000; Gauthier, 1994). Specific experiences mentioned by preservice elementary teachers included taking trips to zoos and museums, caring for animals, building with wooden blocks or LEGOs, and camping (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000). Gauthier (1994) found that preservice elementary teachers described out-of-school experiences as positive 98% of the time. However, in the studies by Ellsworth and Buss (2000) and Bulunuz and Jarrett (2010), out-of-school experiences were described as both positive and negative influences on attitudes toward science. Ellsworth and Buss (2000) found that preservice elementary teachers described feelings of success when they had parental support for activities, but lacked confidence in science when pressured by parents. Bulunuz and Jarrett (2010) found that those preservice elementary teachers with a high interest in science described more experiences in out-of-school science activities than those with a lower interest in science. Based on these studies, informal science activities can have both positive and negative influences on preservice elementary teachers' attitudes toward science.

The Role of Teachers and Classroom Instruction

Preservice elementary teachers frequently mentioned the influence of their teachers when describing their science experiences during the K-12 school years (Ellsworth & Buss, 2000; Gauthier, 1994; Sutton et al., 1993; Talsma, 1997). For example, Sutton et al. (1993) found that preservice elementary teachers with positive science experiences in high school most often recalled teachers who led hands-on activities that included real-world applications. On the other hand, those with negative science experiences in high school most often mentioned teachers whose instruction was primarily lecture or textbook-based (Sutton et al. 1993). Likewise, Talsma (1997) found that preservice elementary teachers linked positive experiences with hands-on activities and negative experiences with textbook-based science instruction.

Similarly, Gauthier (1994) found that preservice elementary teachers linked laboratory activities to positive experiences in science classes. This particular group of preservice elementary teachers also described specific teacher actions, such as lack of enthusiasm or sense of humor and/or preferential treatment of other students, which led to the preservice elementary teachers' negative attitudes toward science and science learning. Based on these studies, preservice elementary teachers described hands-on activities as positive experiences and lectures as negative ones.

In a study conducted by Ellsworth and Buss (2000), preservice elementary teachers shared the influence of their current perceptions toward science teaching and learning through mathematics and science autobiographies. Of the 98 autobiographies collected, over 75% of the participants stated the influence of the teacher as both positively and negatively impacting their attitudes toward mathematics and/or science. These preservice elementary teachers viewed the teacher as being solely responsible for the success or failure of student learning. Overall, these preservice elementary teachers felt their experiences in science classrooms were a contributing factor to their attitudes toward science and science teaching.

Based on Bandura's social cognitive theory (1977), mastery experiences influence a person's self-efficacy. If preservice elementary teachers did not have, or remember, positive mastery experiences from their own elementary science classes, this void could explain the low science teaching self-efficacy found in previously mentioned studies. In addition, this lack of science experiences leaves preservice elementary teachers with a limited number of positive examples from which to draw upon for their future elementary classrooms.

Perceptions of Science Teaching and Learning

According to Bandura (1989), individuals' self-efficacy beliefs can influence the type of future scenarios they anticipate. Individuals with low self-efficacy in a particular area tend to visualize failure scenarios and people with high self-efficacy would visualize successful scenarios. The relationship between self-efficacy and visualization of future scenarios can be examined as it relates to preservice elementary teachers and the scenarios they envision regarding their future classrooms. Specifically, the types of images preservice elementary teachers hold of their own future classrooms.

Finson and Pedersen (2011) argued that perceptions, whether they are good or bad, are the guiding force behind individuals' motivation in pursuing particular endeavors. If people have negative perceptions of science, it could be more difficult to associate positive images with science, including the teaching and learning of science. Providing preservice elementary teachers with opportunities to examine their own perceptions toward science can provide possibilities for (a) preservice elementary teachers' self-reflection and (b) science educators' identification and remediation of preservice elementary teachers' negative perceptions of science (Finson & Pedersen, 2011).

Generalized Perceptions of Science Teaching and Learning

An understanding of the ideas and perceptions preservice elementary teachers bring with them to their science methods course can help instructors modify and implement instruction to meet the needs of future elementary teachers. When asked to describe how students learn science, Gustafson and Rowell (1995) found that preservice elementary teachers felt it was important for students to connect their science learning with hands-on activities. Based on these perceptions, instructors can adapt the science methods course to address and introduce various hands-on activities in which the preservice elementary teachers can then take into their future classrooms.

Seung et al. (2011) used student writings to gain understanding of preservice elementary teachers' perceptions of science teaching and learning. In this study, the researchers identified three categories: (a) the traditional view, where the teacher transmitted knowledge to the students; (b) the constructivist view, where students discovered knowledge for themselves; and (c) the neutral view, where the goal of science instruction was to make the class enjoyable for the students. At the beginning of the science methods course, 57% of these preservice elementary teachers held the traditional view of science teaching and learning (teacher is the focus of instruction), whereas only 11% held the constructivist view (students are the focus of instruction). At the conclusion of the science methods course, 13% held the traditional view of science teaching and learning and 55% held the constructivist view. Based on this study, preservice elementary teachers have perceptions of how science should be taught and also that the science methods course can shift that perception from teacher-centered to student-centered instruction.

Depicting Perceptions as Images

Another method of gaining understanding of how preservice elementary teachers envision science instruction in their future classrooms was to have them draw their perceptions. For example, Weber and Mitchell (1996) instructed both preservice and in-service elementary teachers to "draw a teacher." The majority of the drawings were of traditional images that depicted the teacher as the focus of the classroom (Weber & Mitchell, 1996). Hancock and Gallard (2004) found similar results when preservice elementary teachers were instructed to "draw a picture of yourself as a science teacher" and "draw a picture of someone learning science" (p. 283). The images drawn by the preservice elementary teachers depicted science teachers lecturing to students as well as facilitating hands-on activities.

Mensah (2011) also found that preservice elementary teachers perceived science instruction as an active process. Preservice elementary teachers drew images of what they considered the opposite of an ideal science teacher, resulting in images of teachers standing in front of students where they were lecturing to the class. This study concluded that preservice elementary teachers recognized an ideal science teacher as one who involved students in the process of learning.

Thomas et al. (2001) offered yet another prompt for preservice elementary teachers to illustrate science teaching and learning where they were given the following instructions: “draw a picture of yourself as a science teacher at work” (p. 300). Through this prompt and the resulting images, the researchers developed the Draw-a-Science-Teacher-Test Checklist (DASTT-C) to quantify the images where images were assessed points based on the presence of different characteristics of the teacher, the students, and the classroom environment. The resulting images were placed into one of two categories, depending on the points received: teacher-centered (7-13 total points) or student-centered (0-4 total points). The researchers also established the validity and reliability of the DASTT-C instrument for assessing participants’ visual perceptions of themselves as a science teacher.

In studies conducted by Minogue (2010) and Ucar (2011), preservice elementary teachers completed the DASTT-C at the beginning and end of a science methods course. As a result of the science methods course, preservice elementary teachers’ images of themselves as science teachers shifted from teacher-centered to student-centered images. The studies by Minogue (2010) and Ucar (2011) support those of Seung et al. (2011) that preservice elementary teachers typically began their science methods course with a teacher-centered perception of science teaching and learning, yet shift to a student-centered perception by the end of the course.

Talsma (2007) used the DASTT-C to analyze images drawn by preservice elementary teachers of children learning science. Similar to the findings of Minogue (2010), Ucar (2011) and Seung et al. (2011), it appears that preservice elementary teachers shift their perceptions of science teaching and learning as a result of the science methods course, regardless of the specific prompt used.

When prompted to visualize these perceptions, preservice elementary teachers began their science methods course with a traditional, teacher-centered view of science teaching and learning (Hancock & Gallard, 2004; Minogue, 2010; Talsma, 2007; Ucar, 2011; Weber & Mitchell, 1996). These researchers concluded preservice elementary teachers' initial views of science teaching and learning was one of a teacher-led process where the teacher was responsible for providing hands-on instruction in order to transfer scientific knowledge to the students. These studies have found that many preservice elementary teachers hold stereotypical views of science teaching and learning.

If self-efficacy is influenced by experience which guides future perceptions of science, then it is important to understand the relationships between these constructs. The next section reviews studies that examined the relationship between: (a) self-efficacy and past science experiences, (b) perceptions of science teaching and learning and past science experiences, and (c) self-efficacy and perceptions of science teaching and learning.

Relationship between Self-Efficacy, Experience, and Perceptions

Self-Efficacy and Experiences

Researchers have examined the relationship between self-efficacy and science experiences through the use of the STEBI-B (Bleicher, 2004; Bleicher & Lindgren, 2005; Cantrell, Young, & Moore, 2003; Tosun, 1994; Watters & Ginns, 1995, Yuruk, 2011) and other open-ended formats (Sutton et al., 1993; Talsma, 1997; Tosun, 2000). Tosun (1994) employed background questionnaires and autobiographies and determined that no difference existed between preservice elementary teachers who reported higher letter grades and those who reported lower letter grades on either subscale of the STEBI-B. However, when prompted, these preservice elementary teachers described more negative than positive science experiences in both elementary and secondary school years.

Through a combination of the STEBI-B and interviews, Watters and Ginns (1995) found that preservice elementary teachers attributed their lack of interest in science to their negative science experiences in high school. Additionally, these teachers attributed their positive attitudes toward science with practical or hands-on work in science classes, indicating a correlation between interest in science and PSTE scores. Cantrell et al. (2003) found a relationship between extracurricular high school science activities (e.g., science fairs and/or science clubs) and higher scores on the PSTE subscale for preservice elementary teachers. When describing past experiences, Bleicher and Lindgren (2005) found that those preservice elementary teachers who reported positive experiences in K-12 science had significantly higher self-efficacy on both the pre and posttest.

Bleicher (2004) and Yuruk (2011) conducted studies where the administration of the STEBI-B occurred only once and preservice elementary teachers provided information about their past science courses, including the type, grades received, and overall perception of their past science experiences. Bleicher (2004) and Yuruk (2011) found statistically significant differences between science experiences described by preservice elementary teachers and their scores on the PSTE subscale, indicating positive experiences led to higher PSTE scores. Overall, studies indicated that science achievement did not influence self-efficacy, yet the type of science experience was influential in both interest and personal science teaching self-efficacy.

Talsma (1997) found, through science autobiographies, that preservice elementary teachers linked negative experiences with textbook-based instruction and positive experiences with hands-on science instruction and experiences outside of the classroom, which they used to justify their current attitudes toward science teaching. Tosun (2000) found, through interviews, that negative feelings were more influential than achievement on science teaching self-efficacy, even when preservice elementary teachers had experienced academic achievement in science. Sutton et al. (1993) found, through a questionnaire and interviews, that experiences seemed to have a very significant effect on preservice elementary teachers' attitudes toward science. Overall, types of science experiences were more influential to science teaching self-efficacy than achievement in science.

Despite these differences in STEBI-B scores, these studies did report similar findings describing past experiences. The preservice elementary teachers from these three studies indicated their past experiences influenced in their attitudes toward science and their beliefs in their abilities to teach science in the future. It appears there are more consistent results when describing the relationship between past experiences and self-efficacy than describing the effects of a science methods course on self-efficacy.

Perceptions and Experiences

Researchers also have studied the direct relationship between science experiences of preservice elementary teachers and their perceptions of science teaching and learning. For example, Knowles (1992) examined the backgrounds and science experiences of five preservice elementary teachers, and the results pointed to three factors important in the formation of an image of self as teacher: (a) early childhood experiences; (b) early teacher role models; and (c) previous teaching experiences. Similarly, Gustafson and Rowell (1995) found that regardless of the types of science experiences, preservice elementary teachers' initial ideas about science teaching and learning came from their lived experiences. Based on these studies, personal experience with science helped to shape teachers' understanding of science teaching and learning.

However, other researchers have found differing results. Ramey-Gassert, Shroyer, and Staver (1996) found that in-service elementary teachers who experienced poor science teaching grew to dislike science and wanted to make science an enjoyable subject for their students. Through case studies with two preservice secondary science teachers, Eick and Reed (2002) found that each experienced science instruction differently, yet both described their experiences positively. For example, one participant remembered that her high school biology teacher conducted many hands-on activities and stated that she wanted to teach like her in the future. Whereas the other participant had positive experiences with traditional forms of learning (i.e., lecturing) and wanted to teach using that method (Eick & Reed, 2002). Jarrett (1999) concluded that interest in science and models of good teaching came from a good elementary school experience, which also enhanced prospective teachers' confidence that they can teach well. These studies illustrated that preservice elementary teachers described the same type of experience (i.e., lecture) as either positive or negative and used those experiences to influence their perceptions of science teaching in the future.

When preservice elementary teachers discussed their images of science teaching, the influence of lived science experiences became evident (Van Zee & Roberts, 2001; Weber & Mitchell, 1996). Weber and Mitchell (1996) found that once preservice elementary teachers reflected on their images, they became aware of the incredible power of experiences. Specifically, Van Zee and Roberts (2001) found that drawings of preservice elementary teachers' science experiences revealed negative experiences in science courses, which led to anxiety towards the teaching of science.

Thomas et al. (2001) found that the replication of room arrangements within the images drawn by preservice elementary teachers seemed to be rooted in their science classroom experiences. In addition, Thomas and Pedersen (2003) found that images showed positive experiences the preservice elementary teachers wanted to repeat with their future students or negative experiences which they wanted to improve upon for the future.

Overall, the research literature indicated that preservice elementary teachers remembered positive experiences in elementary school (if they remembered science at all) and negative experiences in secondary school. These experiences, both positive and negative, were influential in the development of attitudes and perceptions of science teaching and learning. Preservice elementary teachers typically wished to replicate their positive experiences and modify their negative experiences so as not to repeat the experience for their future students (Thomas & Pedersen, 2003).

Self-Efficacy and Perceptions

Finson (2001) combined the STEBI-B and DASTT-C to examine a possible relationship between science teaching self-efficacy and perceptions of science teaching held by preservice elementary teachers. Administration of these two instruments occurred both at the beginning and end of a science methods course. Results indicated that the images drawn by the participants and the accompanying narratives became less stereotypical, or teacher-centered, and self-efficacy increased over the course of the semester. In general, as preservice elementary teachers became less stereotypical in their images of science teaching, their self-efficacy in science teaching increased.

Conclusion

According to Knowles and Holt-Reynolds (1994), the present lives of teachers are connected to both their past and their future. By understanding this connection, teachers can begin to fully examine their role in the classroom (Knowles & Holt-Reynolds, 1994). Research does indicate a complex relationship between self-efficacy, experiences, and perceptions of science teaching and learning. One view of this relationship was that it is the type of experience a person had that was most influential in developing attitudes and self-efficacy of science teaching and learning (Cantrell et al., 2003; Sutton et al., 1993; Talsma, 1997; Tosun, 1994, 2000; Watters & Ginns, 1995). The second view of this relationship was that the science experiences of preservice elementary teachers were influential in the types of classrooms they envisioned, indicating the replication of positive experiences and the modification of negative ones (Eick & Reed, 2002; Jarrett, 1999; Ramey-Gassert et al., 1996; Thomas & Pedersen, 2003; Van Zee & Roberts, 2001). Finally, preservice elementary teachers typically began their science methods course with low to moderate levels of perceived science teaching self-efficacy and stereotypical views of teacher-centered science learning, which may be influenced by science methods courses (Finson, 2001).

However, no studies were found to combine the STEBI-B, the DASTT-C, and science autobiographies to examine preservice elementary teachers' perceptions of science teaching and learning. By utilizing the STEBI-B and DASTT-C in connection with science autobiographies, one can provide a more complete picture of the influence of experiences on perceived self-efficacy and images of science teaching of preservice elementary teachers. This chapter reviewed literature relevant to the relationship between self-efficacy, past science experiences, and perceptions of science teaching and learning, as it relates to social cognitive theory. In the next chapter, the researcher presents the methodology for each phase of the study, describing the collection and analysis techniques used in the study.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this chapter is to outline the mixed methods research design used in the study. The researcher will outline the specific data collection and analysis techniques used for both phases of the mixed methods study. In addition, the researcher will discuss the ethical considerations and her role in the collection and analysis process.

Mixed Methods Research Design

In order to better understand preservice elementary teachers' understanding and perceptions of science teaching and learning, this study used a sequential, two-phase, explanatory mixed methods design (Creswell & Plano-Clark, 2011). Mixed method approaches allowed the researcher to answer questions that using only quantitative or qualitative research methods could not. Mixed methods research in this study involved more than just collecting and analyzing both forms of data, but also used both methods in tandem to strengthen the study. Collecting and analyzing both numerical and text data allow the researcher to better understand the research problem. Using archived data from former preservice elementary education majors, this design involved collecting and analyzing quantitative data in the first phase and then qualitative data in the second phase (see Figure 3.1). This allowed the researcher to more fully examine the complex topic of preservice elementary teachers' understandings and perceptions of science teaching and learning.

In the quantitative phase of the study, the researcher analyzed archived responses to the Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990) completed by preservice elementary teachers. This instrument measured preservice elementary teachers' personal science teaching efficacy and science teaching outcome expectancy. In addition, the researcher analyzed archived responses to the Draw-a-Science-Teacher-Test Checklist (DASTT-C) (Thomas et al. 2001). The DASTT-C allowed quantification of preservice elementary teachers' images of themselves as future science teachers.

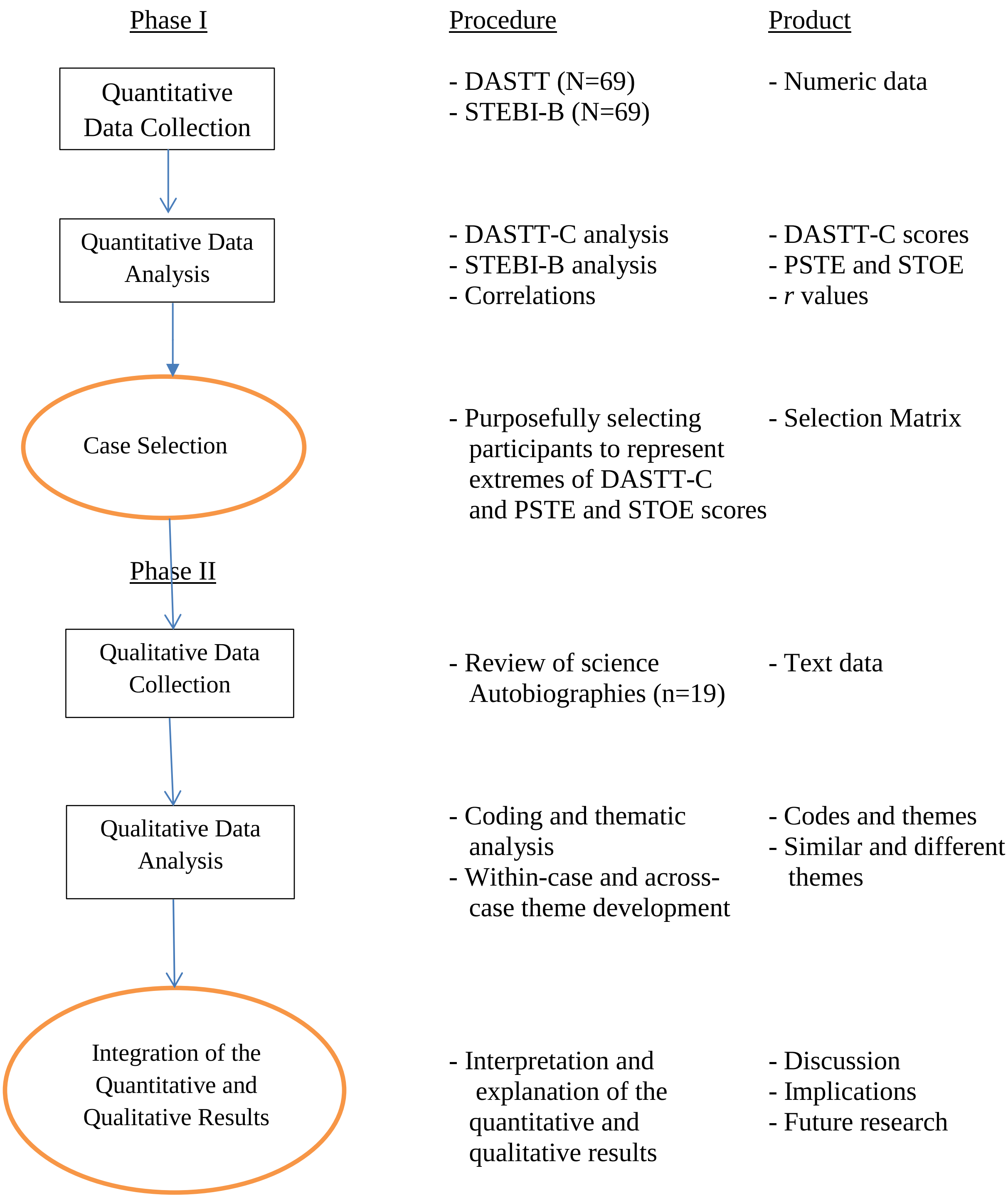

Figure 3.1. Mixed Methods Explanatory Sequential Design Diagram

Prior to the qualitative phase of this study, the researcher sorted the cases in a selection matrix based on participants' scores on the two subscales of the STEBI-B and the overall DASTT-C score (see Figure 3.2). Within each section of the matrix, a combination of high/low scores on the two subscales of the STEBI-B and the overall DASTT-C score is represented. The researcher selected cases for the qualitative phase of the study from each section of the matrix. The researcher analyzed the science autobiographies of the selected cases for patterns and themes as they related to perceptions of science teaching and learning. The rationale for this approach was that the quantitative data and results would provide a glimpse of the overall picture, whereas the qualitative data and analysis would add depth and explanation to the preservice elementary teachers' responses.

	PSTE				
DASTT-C	Group 1 High PSTE High STOE High DASTT-C	Group 2 Low PSTE High STOE High DASTT-C	Group 3 High PSTE Low STOE High DASTT-C	Group 4 Low PSTE Low STOE High DASTT-C	STOE
	Group 5 High PSTE High STOE Low DASTT-C	Group 6 Low PSTE High STOE Low DASTT-C	Group 7 High PSTE Low STOE Low DASTT-C	Group 8 Low PSTE Low STOE Low DASTT-C	

Figure 3.2. Science Autobiography Selection Matrix

Mixed Methods and Science Education Research

The researcher found multiple studies that utilized a mixed methods approach to examine preservice elementary teachers' interest and/or self-efficacy in science teaching and their science experiences prior to science methods instruction (Sutton et al., 1993; Tosun, 1994; Watters & Ginns, 1995). In these studies, preservice elementary teachers completed either the STEBI-B or other survey focusing on their perceptions of science teaching and learning. Next, preservice elementary teachers participated in interviews to discuss their science experiences and the potential influence on their current perceptions of science teaching and learning. By utilizing a mixed methods approach, these researchers were able to understand the role that past science experiences played in influencing current perceptions of science teaching and learning.

The researcher found only one study that utilized a mixed methods approach to examine preservice elementary teachers' DASTT-C images and science experiences (Thomas & Pedersen, 2003). After completing DASTT-C images at both the beginning and end of the science methods course, select participants discussed, through interviews, the influences behind these images and how the images changed. This current study uniquely explored three pieces of data—STEBI-B, DASTT-C, and science autobiographies—as a means for gaining greater insight into preservice elementary teachers' perceptions of science teaching and learning.

Advantages and Limitations of the Sequential, Mixed Methods Design

One advantage of this sequential, explanatory mixed methods design was that it was easy for a single researcher to implement, as it sequentially proceeded from one stage to another. Data collected and analyzed in the first phase was completed before the second phase began. Thus, one researcher could focus on each phase of data collection and analysis at a time.

A second advantage of this sequential explanatory mixed methods design was that it allowed the researcher to explore quantitative results in more detail. Results found in the first phase guided the focus of data analysis during the second phase. This second phase added exploration and strengthened the results found in the first phase.

A third advantage of this mixed methods design was that the quantitative section was written first, making the final report straightforward to write and for readers to follow (Creswell & Plano-Clark, 2011). The format of this report indicates the separate methods of data collection and analysis, identifying methods used in both phases. The report then described how the separate methods strengthened each other, identifying how the first phase leads to the second phase and how the second phase strengthens the first phase.

One limitation of this mixed methods design was the length of time required to complete the study. Data collection and analysis for the second phase occurred only upon the completion of data collection and analysis from the first phase. Depending on the length of time taken to analyze data from the first phase, it would delay the start of data analysis for the second phase.

A second limitation of this mixed methods design is that it required abilities and skills necessary to collect and analyze both types of data. The researcher needed to be familiar with the collection and analysis methods used in both quantitative and qualitative research. These methods included the use of statistical programs (SPSS, version 20) and analyzing text for patterns and themes.

A third limitation of this mixed methods design was that all data in this study was self-reported by the participants. As such, participants may not have remembered all experiences from their prior science classes, especially elementary school due to the amount of time that has passed. This lack of memory could possibly affect the analysis of relationships between results from both phases of the study, limiting analysis of the relationship.

Phase I: Quantitative

Participants

The population of this study consisted of preservice elementary education majors enrolled in an elementary science methods course at a large Midwestern university. The researcher used convenience sampling for the quantitative phase of the study (Creswell, 2008). The population consisted of all students enrolled in the elementary science methods course during the fall semester of the 2012 school year (N=70). Sixty-nine students consented to be a part of the data set, representing 99% of all students enrolled during that semester.

Data Collection

The researcher collected the data for this study from a database held by a faculty member at the university in the Midwestern United States. The collected archived data was de-identified and individuals were given a code that is common across all instruments to match measures across cases. The lead faculty member of the science methods course assigned the codes to all instruments, and the researcher did not have access to the coding sheet. The STEBI-B and DASTT-C were completed during the first class meeting of the elementary science methods course.

Instruments

STEBI-B. The Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990) measured preservice elementary teachers' perceptions of their beliefs in their ability to teach science. This questionnaire consisted of 23 items in which participants indicated their level of agreement to statements using a 5-point Likert-type scale ranging from Strongly Disagree to Strongly Agree (see Appendix A). The 23 items on the STEBI-B instrument consists of two subscales: personal science teaching efficacy subscale (PSTE) and science teaching outcome expectancy subscale (STOE). Ten of the 23 items were negatively worded, thus requiring reverse scoring to produce consistent values (Enochs & Riggs, 1990).

Original factor analysis conducted for each of the subscales within the STEBI-B resulted in an alpha coefficient of .90 for the PSTE subscale and .76 for the STOE subscale, thus establishing construct validity (Enochs & Riggs, 1990). Bleicher (2004) re-examined the reliability and validity of the STEBI-B due to the amount of time that had passed since its development. Results from this study upheld the reliability and validity of the instrument, with modifications regarding the wording of two questions; the word "some" was deleted on items 10 and 13 (see Appendix A). The researcher used this modified version of the STEBI-B.

DASTT-C. Thomas et al. (2001) developed the Draw-a-Science-Teacher-Test Checklist (DASTT-C) to quantify the images drawn by preservice elementary teachers. The prompts on the DASTT-C specifically asked participants to draw themselves as a science teacher and then explain what they, as the teacher, and their students are doing (see Appendix B for the DASTT-C). Five reviewers, who individually scored a set of images and determined the instrument's relevance, established the construct validity of the DASTT-C with their analysis.

Data Analysis

STEBI-B. The researcher entered participants' responses to the STEBI-B into SPSS, version 20, for statistical analysis. Participant scores on the two subscales within the STEBI-B instrument were calculated by summing up responses for each subscale separately. Higher participant scores on each subscale were associated with higher positive (a) beliefs in their ability to teach science effectively (PSTE subscale) and (b) influence on student outcomes (STOE subscale). A mean for each subscale was determined for the group of participants. The researcher used inter-item correlation matrices and determined the Cronbach's alpha for each subscale to establish the reliability of each subscale.

DASTT-C. The researcher analyzed the preservice elementary teachers' DASTT-C using the protocol established by Thomas et al. (2001). The researcher scored the DASTT-C images in three different categories: teacher, student, and environment. Images received one point for each characteristic within the three categories. Each preservice elementary teacher received a raw total score, ranging from 0-13, in order to determine how they envisioned themselves as science teachers. A high score (7-13 points) on the DASTT-C indicated more teacher-centered perceptions, and a lower score (0-4 points) indicated more student-centered perceptions. Images which received 5-6 points were not clearly teacher-centered or student-centered.

Comparing STEBI-B and DASTT-C Scores. The researcher used SPSS, version 20, to determine the Pearson product-moment correlation coefficient between the two subscales of the STEBI-B and the participants' raw scores on the DASTT-C and both of the subscales of the STEBI-B to determine if a relationship existed between preservice elementary teachers' science teaching self-efficacy, their outcome expectancies, and their vision of themselves as a science teacher.

Phase II: Qualitative

The qualitative phase of this study focused on explaining the results of the statistical tests obtained in the first phase. A multiple case studies design (Creswell, 2007) was used for collecting and analyzing the qualitative data. Based on the results from the first phase a select number of preservice elementary teachers' science autobiographies were the focus of this phase.

Data Selection Matrix

In the second phase of the study, the researcher purposefully sampled cases from the archived data in the first phase (Creswell & Plano-Clark, 2011). Due to the nature of the sequential design of this study, the selection of the cases for the second phase depended on the results from the first phase. The researcher utilized the selection matrix (refer to Figure 3.2) to select those cases with a combination of extremely high and low scores on the DASTT-C and the two subscales of the STEBI-B as well as a representative sample from other sections of the selection matrix. The high/low values were determined using the categories defined by Finson (2001). Those in the high group had an individual score greater than or equal to one standard deviation above the group mean, and those in the low group had an individual score less than or equal to one standard deviation below the group mean, for each of the STEBI-B subscales and the DASTT-C (Finson, 2001).

Data Collection

Within the first week of the elementary science methods course, preservice elementary teachers wrote a science autobiography describing their experiences with science from elementary school, middle school, high school, and college. In particular, students described any influential people or events that impacted their attitudes toward science. Responses to these prompts were typed and submitted via an online classroom system. Appendix C contains the complete list of questions and format of the science autobiography assignment. The researcher only received the responses for questions six through thirteen and fifteen from each participant's autobiography (see Appendix C).

Data Analysis

During qualitative analysis, the researcher coded and analyzed the text data for themes. The steps in this qualitative analysis included: (a) reading through the autobiography in its entirety; (b) coding the data by segmenting and labeling text; (c) using codes to develop themes by combining similar codes; (d) connecting and interrelating themes in narrative; and (e) developing an interpretation of the data (Creswell, 2009).

The researcher analyzed science autobiographies from participants (n=19) who fell in different sections of the matrix established in phase one of the study (refer to Figure 3.2). Data analysis involved developing a detailed description of participants in each section of the matrix. Descriptions included experiences mentioned from elementary, middle, high school, and college as well as any influential events or people as described by the preservice elementary teachers. During analysis, the researcher developed a narrative to describe themes associated with each group.

Research Permission and Ethical Considerations

During both phases of the study, the researcher addressed potential ethical issues. Per requirements of the Institutional Review Board (IRB), the researcher obtained permission for conducting the study. The application for IRB approval outlined the study including a description of each phase. Because this study used archived data and the researcher could not identify individuals, it was classified as research with non-human subjects. See Appendix D for the IRB approval page.

All participants in this study received a code to maintain confidentiality. None of the science autobiographies contained information that would identify the individual. All data was stored in a locked drawer in the researcher's office.

The Role of the Researcher

As an instructor and former classroom science teacher, the researcher brought her own perceptions and biases toward science teaching and learning. The researcher has her own perceptions and visions of classroom science instruction. This researcher views science instruction as a hands-on approach where students are engaged in activities exploring science concepts. This researcher envisions science instruction as a student-led process, where the teacher is there as a guide. However, it is understood that some science instruction needs to occur through lectures, but that should not occur every day in the science classroom.

In addition, the researcher had experiences with science that influenced her self-efficacy and attitudes toward science. The researcher can recall her own science experiences from elementary school through college. Some of these experiences were positive while others were negative. There were science teachers that influenced this researcher in both positive and negative ways ultimately providing guidance as to how she taught in her own science classroom. This researcher chose to focus on the positive experiences and use examples of negative experiences as ways in how not to teach science.

Having obtained multiple degrees in science education, the researcher chose a career in teaching science in the secondary schools. This career selection was rooted in the researcher's positive attitude and self-efficacy toward the teaching and learning of science. Despite any negative experiences, this researcher would state that overall, she has a positive attitude toward science and feels efficacious in her abilities to teach science.

The researcher's attitude toward science teaching and learning may have influenced the interpretation of the relationship under study. The researcher's bias towards science teaching and learning may have influenced the analysis of the preservice elementary teachers' autobiographies. The researcher could have misinterpreted experiences and events described by the preservice elementary teachers, in that what the researcher considers a negative experience, the preservice elementary teachers indicated it as a positive experience.

Being an instructor for one section of the science methods course included in the study, the researcher administered the STEBI-B and DASTT-C and provided the prompts for the science autobiographies. This administration may have influenced the responses given by the preservice elementary teachers. The researcher could have unknowingly emphasized the importance of some experiences over others, such as hands-on activities, experiences outside the classroom, or influences of classroom teachers.

Summary

This chapter described the explanatory, sequential mixed methods design used to examine the relationship between perceived science teaching ability, past science experiences, and preservice elementary teachers' perceptions of science teaching and learning. The purpose of using a mixed methods approach was to add strength to both the quantitative and qualitative results that neither alone could provide. In the first phase, the researcher collected quantitative data to examine preservice elementary teachers' science teaching self-efficacy and their perception of themselves as science teachers. Based on the results from the quantitative phase participants were placed into a selection matrix to guide the selection of participants' science autobiographies for the second phase of the study. Selected participants' science autobiographies were analyzed for themes relating to science experiences prior to the start of the science methods course. In the next chapter, the researcher will present the findings from both of phases individually and then in relation to each other.

CHAPTER IV

FINDINGS

Introduction

In the previous chapter, the researcher outlined the methods used in both phases of the sequential explanatory mixed methods design. In this chapter, the researcher will present the findings from both phases as they relate to the research subquestions.

This study investigated preservice elementary teachers' understandings and perceptions of science teaching and learning. The central research question guiding this study was: What is the relationship between preservice elementary teachers' perceived science teaching ability, past science experiences, and perceptions of science teaching and learning? This chapter presents the findings of this study in three sections. The first section presents the findings from the quantitative phase of the study which examined preservice elementary teachers' responses to the Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990) and their images on the Draw-A-Science-Teacher-Test Checklist (DASTT-C) (Thomas et al., 2001). The second section presents the findings from the qualitative phase of the study which examined the science autobiographies written by selected preservice elementary teachers. The final section presents a summary of the findings from both sections.

Phase I: Quantitative Findings

This section presents the findings from the first phase of the study according to the associated research sub-questions.

Subquestion 1: What are the personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) beliefs of preservice elementary teachers as measured by the Science Teaching Efficacy Belief Instrument (STEBI-B)?

Preservice elementary teachers' responses to the STEBI-B were entered into SPSS, version 20, for statistical analysis. Table 4.1 provides the descriptive statistics for each subscale of the STEBI-B administered in the fall 2012 semester.

Table 4.1. Descriptive Statistics for Subscales of the STEBI-B

Subscale	Mean	Median	Mode	IQR	Range	SD	Cronbach's alpha
PSTE	45	45	46	40.5-50	22-59	7.28	.866
STOE	35.7	36	45	33-38.5	27-44	3.86	.665

Note: PSTE: Personal Science Teaching Efficacy subscale; STOE: Science Teaching Outcome Expectancy subscale

The high standard deviation (SD) value on the PSTE subscale indicated a wide variation in levels of personal science teaching efficacy for the preservice elementary teachers. The inter-quartile ranking for the PSTE subscale was 40.5 to 50, indicating that 50% of these scores were in that range. The STOE subscale had a lower SD value than the PSTE subscale, indicating these scores had less variation. The inter-quartile ranking for the STOE was 33 to 38.5, indicating that 50% of these scores were in that range. However, the mean value was lower on the STOE subscale than the PSTE subscale, indicating that these preservice elementary teachers had a lower level of self-efficacy towards affecting student outcomes than self-efficacy in their abilities to teach science.

The Cronbach's alpha calculated for the PSTE subscale was .866 in the current study and established the reliability of the PSTE subscale. The Cronbach's alpha calculated for the STOE subscale was .665 in the current study. This low value did not establish the STOE subscale as a reliable measure of these preservice elementary teachers' beliefs in their perceived abilities to affect student outcomes. As such, the STOE subscale scores were not included further in any analysis.

Subquestion 2: How do preservice elementary teachers depict themselves as science teachers as measured by the Draw-a-Science-Teacher-Test Checklist (DASTT-C)?

The researcher scored preservice elementary teachers' drawings according to the guidelines outlined by Thomas et al. (2001). Each participant received a total score for their image. The researcher entered the resulting scores into SPSS, version 20, for statistical analysis. Table 4.2 presents descriptive statistics for scores on the DASTT-C. Table 4.3 presents the frequencies for each category of the DASTT-C.

Table 4.2. Descriptive Statistics for the DASTT-C

Mean	Median	Mode	IQR	Range	SD
5.32	5.00	2	3-8	1-10	2.67

Table 4.3. Frequencies for Each Category of the DASTT-C

Category	Frequency Percent
Student-centered (0-4 points)	40.6%
Intermediate (5-6 points)	24.7%
Teacher-centered (7-13 points)	34.7%

When looking at the descriptive statistics for the DASTT-C, the inter-quartile ranking (IQR) was 3-8, as shown in Table 4.2. This indicated that 50% of the images drawn by these preservice elementary teachers ranged from 3 to 8 points. According to Table 4.3, the modal frequencies of images in the student-centered range of 0-4 points was 40.6%. However, 34.7% of the images drawn by these preservice elementary teachers fell into the teacher-centered range of 7-13 points. According to these frequencies, a slight majority (59.4%) of these preservice elementary teachers depicted classrooms that were not classified as student-centered.

Subquestion 3: What is the relationship between the DASTT-C scores, PSTE subscale scores and STOE subscale scores for preservice elementary teachers?

Due to the low Cronbach's alpha, scores on the STOE subscale were not included in the analysis for Subquestion 3. The researcher calculated the Pearson product-moment correlation coefficient of the participants' PSTE subscale and DASTT-C scores to determine a possible relationship between these variables. Analysis indicated a very low, positive correlation ($r = .057$) between the PSTE subscale and DASTT-C which was not statistically significant at the $p = 0.05$ level. As such, a relationship between preservice elementary teachers' PSTE subscale scores and their DASTT-C images was not established.

Selection Matrix Development

The researcher modified the original participant selection matrix for the qualitative phase of the study due to the low Cronbach's alpha value of the STOE subscale scores. The researcher modified the selection matrix to consider only participants' scores on the PSTE subscale and the DASTT-C (see Figure 4.1). Groups for the selection matrix were determined using guidelines suggested by Finson (2001). According to these guidelines those in the high group would have a score greater than or equal to one SD above the mean and those in the low group would have a score less than or equal to one SD below the mean.

	High PSTE	**Low PSTE**
High DASTT-C	Group 1: High PSTE (≥ 52) High DASTT-C (≥ 8) n = 5	Group 2: Low PSTE (≤ 38) High DASTT-C (≥ 8) n = 3
Low DASTT-C	Group 3: High PSTE (≥ 52) Low DASTT-C (≤ 3) n = 7	Group 4: Low PSTE (≤ 38) Low DASTT-C (≤ 3) n = 4

Figure 4.1. Modified Selection Matrix for Phase II

Note: Values given for each instrument are the scores required for inclusion within the group. The n values represent the number of participants from the original population who met the score requirements.

Phase I Summary

Analysis of the PSTE and STOE subscales indicated that preservice elementary teachers had a higher level of self-efficacy in their abilities to teach science than towards affecting student outcomes. However, the low Cronbach's alpha for the STOE subscale indicated the results were not reliable measures of these preservice elementary teachers' beliefs in their perceived abilities to affect student outcomes and therefore not included in the remainder of the analysis. Analysis of the DASTT-C indicated a slight majority (59.4%) of these preservice elementary teachers depicted classrooms that were not student-centered. The correlation between the PSTE subscale scores and the DASTT-C scores was not statistically significant, indicating no relationship between these measures. Based on the results from this quantitative phase, the researcher modified the selection matrix to represent the high and low groups for both the PSTE subscale and the DASTT-C.

Phase II: Qualitative Findings

Subquestion 4: How do preservice elementary teachers' science autobiographies explain their scores on the PSTE subscale, the STOE subscale, and the DASTT-C?

The qualitative phase in this study focused on explaining the results of the statistical tests obtained in the quantitative phase. However, due to the lack of reliability on the STOE subscale, it was not included in the analysis for the qualitative phase of the study. The researcher first analyzed the science autobiography statements of each question for themes within the four different groups of the modified selection matrix. Then the researcher condensed the first themes based on commonalities. Next, the researcher analyzed the science autobiography statements for themes across the four groups. Themes which emerged are presented for each of the four groups and then for all groups as a whole. Table 4.4 lists the codes and expanded codes for each of the themes. The researcher references quoted statements from participants according to their pseudonym and the specific line number(s) in the autobiography transcripts, which are presented within parentheses. All pseudonyms are female in gender due to the high number of females enrolled in the science methods course. Since the autobiographies did not contain any identifiers and the researcher did not collect demographic information, the researcher was unable to identify a specific gender and assumed female genders due to past enrollment in the science methods course.

Table 4.4. Autobiography Themes, Codes, and Expanded Codes

Themes	**Code**	**Expanded Code**
Influences	I:HP	home/parents
	I:STN	school/teacher negative
	I:STP	school/teacher positive
	I:FS	future students
	I:FP	fictional person
School		
Elementary	ES:N	negative experiences
	ES:P	positive experiences
	ES:FMN	few memories/neutral
	ES:FYO	1st year mentioned only
Secondary	SS:NM	no memory
	SS:NTI	negative teacher and/or instruction
	SS:MPN	mixed, positive and negative experiences
	SS:PTI	positive teacher and/or instruction
College	C:NTI	negative teacher and/or instruction
	C:MPN	mixed, positive and negative experiences
	C:PTI	positive teacher and/or instruction
	C:PSI	positive, student interest
"Good" Aspects		
Good Day	GD:ML	meaningful learning
	GD:GD	groups/discussion
	GD:HO	hands-on
Good Teacher	GT:P	teacher has patience
	GT:ES	engages students
	GT:KS	knows subject
	GT:TE	teacher is excited to teach
"Bad" Aspects		
Bad Day	BD:TL	teacher lecture
	BD:BW	book work
	BD:SA	student attitude
Bad Teacher	BT:LE	lacks excitement
	BT:NE	not engaging students
	BT:LO	lectures only
	BT:NC	no connections to world
	BT:NK	no science knowledge
Future Classroom	FC:DE	different experiences than teacher had
	FC:MI	meaningful instruction
	FC:I	integrate with other subjects
	FC:NF	not focus on science
	FC:HO	hands-on
	FC:GC	group collaboration/discussion

Group 1: High PSTE/High DASTT-C

Preservice elementary teachers in Group 1 or *High/High* indicated a high level of self-efficacy in their perceived ability to teach science (PSTE subscale score ≥ 52) and depicted teacher-centered classrooms in their drawings (DASTT-C score ≥ 8), as shown in Figure 4.1. Based on these values, the *High/High* group of preservice elementary teachers believes in their abilities to teach science in a teacher-led classroom. This group included five participants with the following pseudonyms: Mandy, Linda, Molly, Heather, and Amy.

High/High preservice elementary teachers described fictional people, home life, and school life as primary positive influences in their attitude toward science. Heather, for example, mentioned Ms. Frizzle from the *Magic School Bus* series (7-8). Home life influences included living on a farm and parents that were involved in the science field. Amy stated that she felt "like [she has] been able to live a little closer to science because [she] live[d] on the farm, especially the life science part" (1-2). Molly's father was a science teacher (1) and Linda's mother worked in the science field (1); both of these careers were influential on their attitudes toward science.

However, preservice elementary teachers had mixed influences from their teachers and school experiences. For example, Heather explained one of her teachers "really motivated [her] to study science…she always made [labs] interactive and engaged us in the various topics" (5-6). On the other hand, Mandy described a school science experience that "it always included too much memorization to be fun" (2).

Positive school experiences for the *High/High* group seemed to involve interactive, hands-on labs led by energetic teachers. For example, Molly described her elementary school experience as "…fun, engaging, and interactive. We always conducted different experiments…" (11-12). Negative school experiences for this group began in high school and seemed to involve worksheets, memorization of science content, and lectures lacking real-world connections. For example, Mandy disliked her high school zoology class "…because of all the terms [she] had to memorize, it seemed like [she] didn't learn anything except definitions" (20-21). Similarly, Heather's high school science classes seemed to focus on memorization. She perceived science as "boring because it just seemed like all we did was notes, notes, and more notes" (25-26).

The ability to recall and describe experiences from secondary school and college was easier than recalling and describing experiences from elementary school for this group of preservice elementary teachers. Linda provided insight into limited elementary science memories by stating: "I don't remember much about my science class because science wasn't the priority" (5-6).

The positive school experiences described by *High/High* preservice elementary teachers paralleled their descriptions of good science days and good science teachers. Good science days involved working and discussing in groups (Molly, 34; Heather, 56) or hands-on learning (Mandy, 37; Amy, 50) that was meaningful (Linda, 26). Similarly, *High/High* preservice elementary teachers expected good science teachers to have patience (Heather, 60), know their subject (Linda, 29), and make class interesting and fun (Mandy, 42-43) through the use of student explorations and investigations (Molly, 40).

The negative school experiences described by *High/High* preservice elementary teachers also paralleled their descriptions of bad science days and bad science teachers. Bad science days included book work without activities (Mandy, 38-39), lectures (Linda, 28; Molly, 36-37; Amy, 52-53), and poorly planned experiments (Heather, 58; Amy, 53). Bad science teachers were described as unfriendly and controlling (Heather, 62-63); unexcited about involving students (Mandy, 44-45); lecturers who gives worksheets (Molly, 43); and did not bring insight into their teaching (Linda, 31).

Based on their past experiences and descriptions of good versus bad days and teachers, these *High/High* preservice elementary teachers described future classrooms aligned with their own positive experiences and descriptions of good science days and good science teachers. For example, Mandy, Molly, Heather, and Amy all mentioned their desire to utilize hands-on activities to engage students (Mandy, 57-58; Molly, 50; Heather, 68-69; Amy, 58-59). In addition to being hands-on, Molly also expected her future classroom to be meaningful and allow students to apply learning in their lives (51-53). Mandy wanted to be sure her "classroom [would] be much more interesting than when [she] was in school" (66-67). The exception was Linda, who mentioned she would "bring in science through literature" (35).

Group 1 Summary. Overall, these *High/High* preservice elementary teachers experienced largely positive influences from fictional people, home and parents, as well as teachers and school. They described both positive and negative experiences throughout their science classes from elementary through college, with experiences becoming more negative as they progressed through school. These *High/High* preservice elementary teachers viewed good science days and good science teachers as those that involved students in hands-on meaningful learning. These *High/High* preservice elementary teachers described bad science days and bad science teachers as lecturers who focused on the textbook. Based on the descriptions of their future classrooms, these

High/High preservice elementary teachers appear to align themselves with the characteristics described of good science teachers.

Group 2: Low PSTE/High DASTT-C

Preservice elementary teachers in Group 2 or *Low/High* indicated a low level of efficacy in their ability to teach science (PSTE subscale score ≤ 38) and depicted teacher-centered classrooms in their drawings (DASTT-C score ≥ 8), as shown in Figure 4.1. According to these values, this *Low/High* group of preservice elementary teachers does not believe in their ability to teach science effectively and envision a teacher-centered classroom. This group included three participants with the following pseudonyms: Melody, Melinda, and Julie.

Preservice elementary teachers in this group described teachers and school as primary influences on their attitude toward science. For example, Melody described her overall science experiences by stating:

> I have never been very excited or eager to study science. Throughout school, I never had a pleasant science experience. Either the teacher, the classmates, or the material being covered caused me trouble in all of my science classes and experiences. Because of this, I have tried to avoid science at all cost until just recently. (1-4)

Melinda described her experiences with science in that "[she] always struggle[d] with science" (26). Julie described science as "…the subject [she] feel[s] the least confident about" (26-27).

These *Low/High* preservice elementary teachers described positive school experiences as those involving hands-on activities. For example, Melinda stated "…[she]

remember[ed] several activities [she] did" which included hatching chickens, planting plants, and watching butterflies change in the stages of their life cycle (18-20). Julie was general in her positive description stating "it was fun and [she] really enjoyed science class in elementary school" (9-10). Julie also described another positive experience stating "[she] loved [her] chemistry teacher and he made [chemistry] make sense to [her]" (15).

Negative experiences for the *Low/High* group seemed to involve a focus on textbooks which were boring and something these preservice elementary teachers struggled with understanding. For example, Melinda stated science involved "lots of text book reading and watching science videos. [She] REALLY started to struggle with science concepts in high school" (21-23). Likewise, Julie stated "science started to become boring and something [she] just did not really enjoy doing in middle school. There were less fun experiments and more memorization of facts from textbooks" (11-13). These experiences continued for Julie as "science in college just became something that [she] dreaded" (18). In addition, Melody stated that "the biggest problem was that [she] never truly understood what [she] was doing and why" (39).

When it came to recalling science experiences, Melody was the only *Low/High* preservice elementary teacher who could not remember science in the elementary school. She stated she did "…not remember doing many science projects in elementary school and [knew] there was no time dedicated to science as a subject on a daily or weekly basis" (11-12).

The positive school experiences described by these *Low/High* preservice elementary teachers paralleled their descriptions of good science days and good science teachers. Good science days involved working and discussing in groups (Melinda, 30-31) or hands-on learning (Julie, 29-30) that was applicable to real-life scenarios (Melody, 67-68). Similarly, *Low/High* preservice elementary teachers expected good science teachers to be patient when implementing multiple teaching techniques (Melinda, 37-38), to engage students (Julie, 37-39) with many different activities to form their own understandings (Melody, 80-83).

The negative school experiences described by these *Low/High* preservice elementary teachers also paralleled their descriptions of bad science days and science teachers. Bad science days included lectures and reading from the textbook (Melody, 70-71; Melinda, 33-34; Julie, 33-35). Bad science teachers were those who stood in front of students and lectured about confusing content (Melody, 74-75; Julie, 40-42).

These *Low/High* preservice elementary teachers described future classrooms that aligned with descriptions of their few positive experiences, good science days, and good science teachers. For example, Melody "…hope[s] to make science a fun but meaningful experience for [her] students" (90-92) which includes "…lots of hands-on activities…" (94). Specifically, Melody wants "…to prevent [her] students from having the same [negative] experience [she] had with science…" (96). Melinda "think[s] it is just as important to instill the discovery of the other disciplines to science" (44-45). Julie expressed her uncertainty stating "[she is] still not sure how science teaching and learning will look in [her] classroom because [she is] still not entirely comfortable with the idea of having to teach science" (45-47).

Group 2 Summary. The *Low/High* preservice elementary teachers described predominately negative experiences and influences from elementary school through college. These *Low/High* preservice elementary teachers described good science days and good science teachers as those where the students are engaged in learning that applies to their lives, where they can work in groups, and utilize multiple strategies. However, a bad science day and a bad science teacher involved those where the teacher lectures to students and relies on the use of the textbook. These *Low/High* preservice elementary teachers have differing views on science in their future classrooms. For Melody, science will include meaningful and hands-on instruction; whereas Melinda and Julie appear hesitant and uncertain about the ways in which they will teach science in the future.

Group 3: High PSTE/Low DASTT-C

Preservice elementary teachers in Group 3 or *High/Low* indicated a high level of efficacy in their ability to teach science (PSTE subscale score ≥ 52) and depicted student-centered classrooms in their drawings (DASTT-C score ≤ 3), as shown in Figure 4.1. Based on these values, this *High/Low* group of preservice elementary teachers believes in their ability to teach science effectively in a student-centered classroom. This group included seven participants with the following pseudonyms: Carrie, Sally, Jane, Lana, Charlotte, Beth, and Barbara.

Preservice elementary teachers in this group described fictional people, parents, and school life as primary influences in their attitudes toward science. For example, Charlotte described "a television show about a high school chemistry teacher" and stated that "through his eyes, science appear[ed] to [her] in a whole new light and [it] helped [her] like science a lot more" (24-26). Jane discussed the influence of her father in that he "…taught physical science for 7th grade for several years, and was unmistakably [her] influence for [her] love of science" (8-10).

However, the majority of these *High/Low* preservice elementary teachers described teachers and school experiences as influential, either positively or negatively, in shaping their attitudes toward science. For example, Lana, Jane, Beth, and Sally stated positive teacher and school experiences included "hands-on teachers who were full of fun and passion" (Lana, 3-4), who "shared her love of science with our class daily through hands-on experiences and experiments" (Jane, 10-11), who "made science and math fun, the type of fun that students remember" (Beth, 4), and who "was really passionate about science and we got to do several different projects and experiments" (Sally, 3-5). Lana also stated that she has "…always been fond of science…[she has] always liked doing hands-on-things" (1).

These *High/Low* preservice elementary teachers also described negative teacher and school influences. For example, Beth stated "[she] had few teachers that really showed passion for their job...[she] remember[ed] [her] teachers just going through the motions, giving [her] worksheets and tests" (9-11). Likewise, Charlotte stated "[her] science teachers were never that great or happy about teaching science so [her] experience only got more negative as [she] progressed" (17-19). Charlotte also described her difficulty with science stating "[she] mostly just remember[s] having a negative attitude toward science because it was hard for [her]" (15-16).

Positive school experiences for the *High/Low* group seemed to involve interactive, hands-on labs led by fun, knowledgeable teachers who cared about their students and were passionate about science. For example, Beth stated that the "the fifth grade was an exciting year because we did various science experiments" (12-13) and in college "[she] love[d] being hands-on and all of [her] courses provided hands-on labs and activities" (25-26). Lana stated "[she] had more involved teachers who made science fun" and another "teacher was so fun and knowledgeable" (33-34, 38). Likewise, Charlotte stated "[her] professor loved science and loved teaching" (21).

Negative school experiences for the *High/Low* group began in high school and seemed to involve difficulties understanding science and unapproachable teachers who utilized lectures and textbooks. For example, Carrie stated "[she] remember[ed] science being more difficult here [in secondary school]" (20-21). Likewise, Jane described her secondary school experience that "science classes during these years relied heavily on lecture, which for [her] seemed to suck all of the fun and excitement out of science" (25-26). Barbara described her difficulty with college science stating that "not only was that [large class] difficult, but you had to adjust to [the professor's] accent" (28-29). Similarly, Lana stated "[she] did not like [her biology] professor that well….she was hard and not very easy to approach" (44-45).

Several of these *High/Low* preservice elementary teachers described college experiences that appeared to be both positive and negative for them. For example, Sally stated "entomology ended up being a fun class because we got to participate in activities that we could use in our classrooms with our own students…we did have to do a bug collection, which [she] wasn't thrilled about!" (39-41). Likewise, Carrie stated "nutrition class was brutal...[she] did however, like that class the most out of all the science classes [she has] taken in college" (32-33). Jane stated "biology which was a lot harder than [she] had anticipated, but [she] learned so much in that semester that it was well worth the effort" (35-37).

The ability to recall and describe experiences from secondary school and college was easier than recalling and describing experiences from elementary school for some in this *High/Low* group of preservice elementary teachers. For example, Sally stated "[she doesn't] remember a whole lot about [her] elementary years and any science that [she] did" (1-2). Similarly, Charlotte stated "[she does] not really remember a lot of [her] elementary school experiences because nothing sticks out as extremely positive or negative" (4-6).

The positive school experiences described by *High/Low* preservice elementary teachers paralleled their descriptions of good science days and good science teachers. Good science days involved discussions (Carrie, 51) through hands-on activities (Lana, 64; Charlotte, 26-27; Beth, 41-42) that were meaningful and fun (Charlotte, 27-28). Similarly, *High/Low* preservice elementary teachers expected good science teachers to involve students in learning through discussions and various activities (Carrie, 57-58; Sally, 53-58; Jane, 46-49; Charlotte, 32-33; Barbara, 46-47); "show excitement" (Beth, 49); and "know his/her subject matter well" (Lana, 68).

The negative school experiences described by *High/Low* preservice elementary teachers also paralleled their descriptions of bad science days and bad science teachers. Bad days in science involved lectures and book work, with little participation from the students (Sally, 50-51; Jane, 44-45; Charlotte, 30; Barbara, 41; Lana, 66; Beth, 44-45; Carrie, 54-55). Bad science teachers were described as not making learning fun and active (Beth, 53-54; Charlotte, 34) because they assigned readings and lectured (Carrie, 60-61; Jane, 49-50) and had little knowledge of science (Lana, 70-71).

These *High/Low* preservice elementary teachers described their future classrooms as aligned with their own positive experiences, good science days, and good science teachers. For example, Jane, Sally, Lana, Charlotte, and Beth all mentioned their desire to utilize hands-on activities to engage students (Jane, 69; Sally, 69-71; Lana, 79, Charlotte, 42-44; Beth, 61-62). Carrie, Lana, Beth, and Barbara also expected to have students working in groups discussing their learning (Carrie, 67-68; Lana, 82-84; Beth, 64-65; Barbara, 51-54). Finally, Sally, Jane, and Charlotte wish to provide learning that is meaningful and connects to the real-world (Sally, 68-69; Jane, 54-55; Charlotte, 43).

Group 3 Summary. Overall, these *High/Low* preservice elementary teachers described fictional people, parents, and school life experiences which appeared to have either a positive or negative influence on their attitude toward science. They described both positive and negative experiences throughout their science classes from elementary through college, with experiences becoming more negative as they progressed through school. These *High/Low* preservice elementary teachers viewed good days and good science teachers as those involving hands-on activities that engage students in meaningful learning with their classmates. These *High/Low* preservice elementary teachers described bad days and bad science teachers as centered on book work with little involvement of the students. Based on the descriptions of their future classrooms, these preservice elementary teachers appear to align themselves with the characteristics of good science teachers.

Group 4: Low PSTE/Low DASTT-C

Preservice elementary teachers in Group 4, or *Low/Low*, indicated a low level of efficacy in their ability to teach science (PSTE subscale score ≤ 38) and depicted student-centered classrooms in their drawings (DASTT-C score ≤ 3), as shown in Figure 4.1. Based on these values, this *Low/Low* group of preservice elementary teachers does not believe in their abilities to teach science effectively in a student-centered classroom. This group included four participants with the following pseudonyms: Susan, Jennifer, Leah, and Amber.

These *Low/Low* preservice elementary teachers described teachers and school experiences as being influential in their attitudes toward science, either positively or negatively. For example, Jennifer described a teacher who “made learning and exploring science come alive...he would be the only person who has ever sparked [her] interest in science” (3-5). Similarly, Susan described a single instance where a teacher was “amazing at connecting with us on a more personal level but still incorporating science” (3-4). However, Susan also stated that “[she does] believe that by the lack of good, effective teaching caused [her] to have a negative relationship with science, which carried through to college today” (30-31). Amber also stated that “the only really personal events in [her] life that have ever had an impact on [her] science learning [were her] struggle[s] with school and learning in general” (30-31). For Leah, “[her] future students have influenced [her] decision to study science” (12-13).

Positive school experiences for the *Low/Low* group seemed to involve collaborative experiments and fun teachers who helped students make a personal connection to science. Leah described experiences where a local farmer would come into the classroom two times a year and lead the students in experiments (22-25). Leah also described an experience from college stating “the [chemistry] teacher was great and really phrased things in a way that help[ed] [her] to understand” (37-38). Susan stated

"…[her] favorite science class was chemistry because [she] understood the concepts taught and the way [her] teacher explained it" (13-16). Jennifer described an elementary school experience, stating:

> I think I enjoyed his class (environmental science) so much because he had a sense of humor that he incorporated into his class. Science wasn't always a serious matter that required intense concentration. It could be a fun, collaborative experience in which I learned just as much or more than from the textbook. (18-21)

Negative school experiences for this group began early in secondary school and continued through to college and involved textbooks and memorization influenced by their level of interest in the science taught. For example, Jennifer stated "from what [she] remember[ed] about [her] secondary science classes, [she] was always bored…[she] was always taught from textbooks and taught to regurgitate information when needed" (14-16). Jennifer also stated "[she has] absolutely never enjoyed a single science class [she has] taken in college" (22-23). Susan stated "[her] relationship with science went downhill fast when all [she] did was prepare for the [state] test" (10-11). Susan also stated "college science courses have been extremely hard for [her] because [she has] no interest in them" (17-18). Amber stated "science classes were very hard for [her]…a lot of the information was memorizing definitions for tests" (9-10).

These *Low/Low* preservice elementary teachers also described experiences that were negative, yet they also viewed some positive aspects. For example, Leah stated "[her] science experiences were still awful…[her] high school chemistry teacher made science make sense for [her] though" (28, 30-31). Leah also described a college experience, stating "[she] remember[ed] being so bored with talking about the cell structure, but when we finally got to talk about trees, and how their habitats affected them, [she] liked the class" (34-35). Amber stated "[she] love[s] math so [she] think[s its] the reason [she] like[d] chemistry so much is because of the balancing equations and all the numbers based problems" (28-29).

The ability to recall and describe experiences from secondary school and college was easier than recalling and describing experiences from elementary school for this *Low/Low* group of preservice elementary teachers. For example, Jennifer stated "it is hard for [her] to recall learning and experimenting with much science back in [her] elementary school years" (7-8).

The few positive school experiences described by *Low/Low* preservice elementary teachers paralleled their descriptions of good science days and good science teachers. Good science days involved students interacting in hands-on learning that is meaningful (Susan, 34-35; Jennifer, 44; Leah, 45-46; Amber, 35-36). *Low/Low* preservice elementary teachers expected good science teachers to be passionate about teaching science in an organized way (Susan, 44-45; Jennifer, 54; Amber, 42) engaging students in hands-on activities connecting to the real-world (Jennifer, 56-57; Leah, 46-47; Amber, 44-45).

The negative school experiences described by *Low/Low* preservice elementary teachers also paralleled their descriptions of bad science days and bad science teachers. Bad science days included taking notes while the teacher lectured (Susan, 39-40; Jennifer, 50-51; Leah, 44) and completing book work (Amber, 38-39). Bad science teachers were described as not caring about their subject (Jennifer, 59-60), not interested in teaching (Susan, 45-46; Amber, 46), and lecturers who relied on textbooks and worksheets (Leah, 49-50; Amber, 47).

Based on their past experiences and descriptions of good versus bad science days and teachers, these *Low/Low* preservice elementary teachers described future classrooms aligned with their own positive experiences, good science days, and good science teachers. For example, Amber stated "[her] classroom will be very hands on approach to learning" (56-57). Similarly, Susan stated "[she] want[s] science to be a fun and engaging experience for [her] students and [her]self…[she] also want[s] [her] students to view themselves as scientist[s] and interact in daily activities" (48-49). In addition to having hands-on activities, Leah stated her future classroom will include "group projects and animated conversations and debates about what the next move should be [in experiments]" (61-62). However, Jennifer stated she "…want[s] to teach middle school math, so while [science] can be integrated into some of [her] lessons since math and science are very interconnected, it may not be an everyday experience" (73-74).

Group 4 Summary. Overall, this *Low/Low* group of preservice elementary teachers described experiences with teachers and school that negatively influenced their attitudes toward science. For the majority of this group, science throughout their K-12 and college years appears to be predominantly negative, with few positive experiences. This *Low/Low* group of preservice elementary teachers described good science days and good science teachers as those that engage students in hands-on activities and are excited about being in science class. On the other hand, this group of preservice elementary teachers described a bad science day and a bad science teacher as one where the teacher lectures and neither the teacher nor the students are excited to be in science class. This

Low/Low group of preservice elementary teachers envisioned their future classroom as one that involves students in hands-on learning with group discussions.

Themes Across All Groups

When comparing the science autobiographies across the four groups, there were commonalities, as well as differences that emerged. This section will present these similarities and differences across the four groups for each of the themes that emerged from the science autobiographies.

Influential People or Places. Preservice elementary teachers from Groups 1 (*High/High*) and 3 (*High/Low*) described fictional people, home life, and school life experiences as being influential on their attitudes toward science. Preservice elementary teachers from Groups 2 (*Low/High*) and 4 (*Low/Low*) described only teacher and school experiences as being influential on their attitudes toward science. It appears that the majority of experiences described by Groups 2 (*Low/High*) and 4 (*Low/Low*) were negative influences, whereas Groups 1 (*High/High*) and 3 (*High/Low*) had more positive influences. It would seem that those who described positive influences both inside and outside of the classroom also believed in their ability to teach science effectively. While those who described negative influences, predominantly inside of the classroom, did not believe in their ability to teach science effectively.

School Experiences. School experiences for the four groups of preservice elementary teachers had four commonalities. (a) Some preservice elementary teachers had difficulty recalling any science from their elementary school years. (b) The number of negative experiences seemed to increase as these preservice elementary teachers progressed from elementary school through college. (c) Positive experiences were those that involved energetic and passionate teachers who engaged students in hands-on activities or lab experiments connected to learning. (d) Negative experiences were those that involved unhelpful teachers who lectured and assigned worksheets over difficult scientific concepts.

School experiences for the four groups of preservice elementary teachers had two differences. First, the preservice elementary teachers in Group 3 (*High/Low*) described elementary school science as mostly a positive experience. Second, the preservice elementary teachers in Group 2 (*Low/High*) did not describe any college experiences that appeared to be purely positive.

Good Science Days and Good Science Teachers. Overall, these groups had similar descriptions of good science days and good science teachers. For these groups, it appears good science days are those in which the students are engaged in hands-on learning where they can interact with their classmates and gain meaningful understanding that applies to the real-world. Also for these groups, it appears that good science teachers are those who are excited to teach, knowledgeable about their subject, and engage students in hands-on learning that requires group work and discussions.

Bad Science Days and Bad Science Teachers. Overall, these groups had similar descriptions of bad science days and bad science teachers. For these groups, it appears bad science days are those in which the students must conduct an ill-planned lab, complete worksheets, or write notes while the teacher lectures. Also for these groups, it appears bad science teachers have no desire or excitement to teach, only utilize lectures and the textbook for instructional methods, and do not engage students in their learning.

Future Classroom. When describing their future classroom, several preservice teachers in all four groups mentioned the use of hands-on activities and group discussions where students were engaged in making connections to the real-world. However, there were preservice elementary teachers from Group 2 (*Low/High*) who indicated they were uncomfortable teaching science and would rather teach other subjects.

Summary of Qualitative Findings

After analyzing the science autobiographies written by selected preservice elementary teachers, there appeared to be four commonalities across the groups: (a) the difficulty in remembering science from elementary school; (b) a mixture of positive and negative experiences in secondary school and college science classes; (c) the descriptions of good science days and good science teachers; and (d) the descriptions of bad science days and bad science teachers. These commonalities suggest that these preservice elementary teachers describe science days and teachers that paralleled their own classroom experiences.

There were differences that emerged when comparing the four groups. One difference seems to stem from people who influenced their attitudes toward science. It appears that the majority of experiences described by Groups 2 (*Low/High*) and 4 (*Low/Low*) were negative influences, whereas Groups 1 (*High/High*) and 3 (*High/Low*) had more positive influences both inside and outside of school. Another difference was the types of experiences, when remembered, from elementary school. It seems elementary school science for Groups 1 (*High/High*), 2 (*Low/High*), and 4 (*Low/Low*) were a mixture of positive and negative experiences, whereas Group 3 (*High/Low*) had mostly positive experiences. A third difference between the groups was their future classrooms. The majority of preservice elementary teachers from all groups shared similar visions of their future classrooms, except for a couple of preservice elementary teachers from Group 2 (*Low/High*) who were not comfortable with the idea of teaching science.

Summary

The preservice elementary teachers in this study had scores on the PSTE subscale that ranged from 22 to 59, with a mean of 45, and scores on the STOE subscale that ranged from 27 to 44, with a mean of 35.7. These values indicate that these preservice elementary teachers held a higher level of belief in their abilities to teach science effectively than affect student outcomes in science. However, due to the low Cronbach's alpha value on the STOE subscale, it was not included in further analysis. The preservice elementary teachers in this study had scores on the DASTT-C that ranged from 1 to 10, with a mean of 5.32, indicating the majority of these preservice elementary teachers depicted classrooms that were not student-centered. The researcher did not find a statistically significant correlation between the PSTE subscale and the DASTT-C, indicating no relationship between these measures.

The researcher utilized a modified selection matrix to identify science autobiographies for analysis. These autobiographies showed several commonalities across the different groups of the modified selection matrix, especially in the areas of good science days and teachers and bad science days and teachers. The differences found between the groups focused on influential people and visions of future classrooms.

In the next chapter, the researcher will review the purpose and methodology of the study. In addition, the researcher will review the findings from the two phases of the study. Based on the findings of the study, the researcher will discuss implications and recommendations for future research regarding perceptions of science teaching and learning as they relate to preservice elementary teachers.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Introduction

This chapter will present a summary of the study, including the overall findings, conclusions, and implications. This chapter is organized into the following sections: summary of the study, discussion, implications, limitations, and future research.

Summary of the Study

Statement of the Problem

Preservice elementary teachers come to their science methods course with perceptions of science and its instruction in the elementary classroom. Most often preservice elementary teachers began their science methods course with low to moderate self-efficacy as it pertains to their perceived ability to teach science effectively (Bleicher & Lindgren, 2005; Bursal, 2012; Finson, 2001; Hechter, 2008; Morrell & Carroll, 2003; Tosun, 1994; Wagler, 2007; Watters & Ginns, 1995, 2000). Throughout their personal lives and their schooling, preservice elementary teachers' encounters with science influence their perceptions toward science teaching and learning. In previous research findings, most preservice elementary teachers (a) described their elementary school experiences, when remembered, as being more positive than their secondary school and college experiences and (b) linked their positive experiences with hands-on activities that connected to the real world and negative experiences with lectures or textbook-based instruction (Bulunuz & Jarrett, 2010; Gauthier, 1994; Jarrett, 1999; Sutton et al., 1993; Talsma, 1997).

Other researchers prompted preservice elementary teachers to visualize and discuss their perceptions of science teaching and learning and found that most entered their science methods course with stereotypical, teacher-centered classrooms, where the teacher was responsible for passing on scientific knowledge to students (Hancock & Gallard, 2004; Minogue, 2010; Seung et al., 2011; Talsma, 2007; Ucar, 2011; Weber & Mitchell, 1996). Prior research has examined three main aspects of preservice elementary science teachers: (a) their perceived abilities to teach science, (b) their experiences with science, and (c) their visions their future science classrooms. The current research literature lacks studies that examine the relationship between these three aspects and how they influence preservice elementary teachers' perceptions of science teaching and learning. This study sought to examine that relationship.

The central research question that guided this study was: What is the relationship between perceived science teaching ability, past science experiences, and preservice elementary teachers' perceptions toward science teaching and learning?

The specific subquestions for this study included the following:

1) What are the personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) beliefs of preservice elementary

teachers as measured by the Science Teaching Efficacy Belief Instrument (STEBI-B)?

2) How do preservice elementary teachers depict themselves as science teachers as measured by the Draw-a-Science-Teacher-Test-Checklist (DASTT-C)?

3) What is the relationship between the DASTT-C scores, PSTE subscale scores, and STOE subscale scores for preservice elementary teachers? and

4) How do preservice elementary teachers' autobiographies explain their scores on the DASTT-C, PSTE subscale, and STOE subscale?

Review of the Literature

The review of the literature focused on the following areas: social cognitive theory, self-efficacy, science experiences, and perceptions of science teaching and learning. Bandura (1991) described social cognitive theory as a means for explaining human behavior; through monitoring and self-influence, people develop their behavior in situations. According to Bandura (1989), personal self-efficacy beliefs determine a person's motivation in particular environments, perceived effect of that environment, and courses of action within that environment. As Bandura (1977) explained, people will typically have high self-efficacy if they have mastered similar situations, have seen others master a similarly threatening situation, have been told by others that they can master a threatening situation, or do not feel overly stressed when confronted with a threatening situation.

Researchers have found conflicting results regarding the effects of a science methods course on preservice elementary teachers' STEBI-B scores. Morrell and Carroll (2003), Utley et al. (2005), Watters and Ginns (2000), and Bursal (2012) found PSTE subscale scores increased and STOE subscale scores decreased as a result of participation in a science methods course. Ginns et al. (1995) found the opposite effect, where PSTE subscale scores decreased and STOE subscale scores increased. Hecther (2008) found that scores for both subscales decreased.

Overall, preservice elementary teachers tend to remember science from the secondary and college levels more often than the elementary levels (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000; Gauthier, 1994; Jarrett, 1999; Jesky-Smith, 2002; Sutton et al., 1993). Yet these memories of secondary and college levels are not always more positive than those from elementary school (Bulunuz & Jarrett, 2010; Jarrett, 1999; Steele et al., 2013; Sutton et al., 1993). Preservice elementary school teachers remember elementary science as being fun, interesting, and hands-on (Bulunuz & Jarrett, 2010; Jarrett, 1999; Steele et al., 2013) or focused on the use of a textbook (Jesky-Smith, 2002; Sutton et al., 1993). Previous studies indicated that preservice elementary teachers frequently mentioned their teachers and parents as playing influential roles, although not always as a positive influences, in their attitudes and perception of science (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000; Gauthier, 1994; Sutton et al., 1993; Talsma, 1997).

Some preservice elementary teachers envisioned science teaching and learning to occur through hands-on activities (Gustafson & Rowell, 1995; Hancock & Gallard, 2004; Mensah, 2011; Seung et al., 2011). Other preservice elementary teachers envisioned science teaching and learning to be a teacher-led process (Hancock & Gallard, 2004; Minogue, 2010; Seung et al., 2011; Talsma, 2007; Ucar, 2011; Weber & Mitchell, 1996). Preservice elementary teachers, who began their science methods course with a teacher-led vision, tended to shift toward a student-centered classroom by the end of the course (Minogue, 2010; Talsma, 2007; Ucar, 2011).

Several studies examined the different combinations of efficacy, experience, and perceptions of preservice elementary teachers. Some studies found that the type of experience had by a preservice elementary teacher was influential in both their interest in science and their personal science teaching self-efficacy (Cantrell et al., 2003; Sutton et al., 1993; Talsma, 1997; Tosun, 2000; Watters & Ginns, 1995). Some studies found that both positive and negative experiences influenced the development of preservice elementary teachers' visions of future science teaching and learning, where positive experiences could be replicated and negative experiences modified (Eick & Reed, 2002; Gustafson & Rowell, 1995; Jarrett, 1999; Knowles, 1992; Ramey-Gassert et al., 1996; Thomas & Pedersen, 2003; Thomas et al., 2001; Van Zee & Roberts, 2001; Weber & Mitchell, 1996). However, the researcher identified no studies that examine the relationship between all three factors.

Participants

The population of this study was preservice elementary education majors enrolled in an elementary science methods course at a Midwestern university. The number of students who had consented to be a part of the study was 69, representing 99% of all students enrolled during that semester.

Discussion

Subquestion 1 – What are the personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) beliefs of preservice elementary teachers as measured by the Science Teaching Efficacy Belief Instrument (STEBI-B)?

This study found that preservice elementary teachers' scores on the PSTE subscale ranged from 22 to 59, with a mean of 45 and a standard deviation of 7.28, and scores on the STOE subscale ranged from 27 to 44, with a mean of 35.7 and a standard deviation of 3.86. The high mean value on the PSTE subscale indicates these preservice elementary teachers, on average, have a moderately high level of their perceived abilities to teach science. When comparing the PSTE and STOE subscales overall, this group of preservice elementary teachers has a higher level of belief in their perceived abilities to teach science than to affect student outcomes in science. However, the STOE subscale had a Cronbach's alpha value of .665, thus not establishing this subscale as a reliable measure of preservice elementary teachers' perceptions of their abilities to affect student outcomes in science. Due to this low Cronbach's alpha value, the STOE subscale was not included in any further analysis.

The results of these subscale scores coincide with the pre-test scores found in several other studies (Bleicher & Lindgren, 2005; Bursal, 2012; Enochs & Riggs, 1990; Finson, 2001; Tosun, 1994; Utley et al., 2005; Watters & Ginns, 2000). Pre-test PSTE subscale mean values from these studies ranged from 42.111 to 52.63 and SD values ranged from 5.67 to 8.025. Based on these values, preservice elementary teachers' PSTE subscale scores are similar to those from the previous studies, indicating preservice elementary teachers are neither extremely high or low in their beliefs in their abilities to teach science effectively.

Subquestion 2 – How do preservice elementary teachers depict themselves as science teachers as measure by the Draw-a-Science-Teacher-Test-Checklist (DASTT-C)?

Analysis of the DASTT-C showed scores for preservice elementary teachers ranged from 1 to 10, with a mean of 5.32 and a standard deviation of 2.67. Of the drawings, 40.6% of the images drawn by these preservice elementary teachers fell into the student-centered category of 0-4 points; whereas, 34.7% of the images drawn by these preservice elementary teachers fell into the teacher-centered range of 7-13 points. According to these frequencies, a slight majority (59.4%) of these preservice elementary teachers depicted classrooms that were not classified as student-centered.

Other studies that also analyzed DASTT-C images of preservice elementary teachers indicated mean scores for the images ranged from 5.18 to 8.24 and SD ranged from 1.42 to 2.45 (Finson, 2001; Talsma, 2007; Ucar, 2011). By comparison, the DASTT-C images drawn by preservice elementary teachers in this study appear to be closer to the lower end of the range from other studies, where classrooms are more student-centered. It would appear that preservice elementary teachers in this study were more likely to draw student-centered classrooms than preservice elementary teachers from other studies.

Subquestion 3 – What is the relationship between the DASTT-C scores, PSTE subscale scores and STOE subscale scores for preservice elementary teachers?

Utilizing a Pearson product-moment correlation analysis indicated no statistically significant correlation ($r = .057$) between PSTE subscale and DASTT-C at the $p = 0.05$ level. Finson (2001) also conducted a Pearson product-moment correlation analysis between groups with high scores and groups with low scores on the PSTE subscale and their DASTT-C scores, and found positive and high correlations for low PSTE subscale scores and moderate and negative correlations for high PSTE subscale scores. Correlations between PSTE subscale scores and DASTT-C scores from this present study were not as high as those reported in the study by Finson (2001), indicating that the scores from the PSTE subscale and DASTT-C for this particular group of preservice elementary teachers were less likely related than those presented by Finson (2001). Again, the STOE subscale was not included in the correlations due to the low Cronbach's alpha value. With only the study by Finson (2001) and the current study for comparison, there is a need for further examination of the relationship between the STEBI-B and DASTT-C to make a definitive connection.

Subquestion 4 – How do preservice elementary teachers' autobiographies explain their scores on the DASTT-C, PSTE subscale, and STOE subscale?

After analyzing the science autobiographies written by selected preservice elementary teachers ($n = 19$), as determined by the selection matrix, there appeared to be several commonalities across the four different groups. One commonality across the groups appears to be the difficulty in remembering science from elementary school. This particular commonality supports the finding from several others studies indicating the difficulty in remembering experiences from elementary school (Bulunuz & Jarrett, 2010; Ellsworth & Buss, 2000; Gauthier, 1994; Jarrett, 1999; Jesky-Smith, 2002; Ramey-Gassert et al., 1996; Sutton et al., 1993). It appears this group of preservice elementary teachers, like those in other studies, had a difficult time remembering science from their elementary years.

A second commonality across the groups was the occurrence of what appears to be a mixture of positive and negative experiences in secondary school and college science classes. Positive experiences were those that involved energetic and passionate teachers who engaged students in hands-on activities or lab experiments connected to learning. Negative experiences were those that involved unhelpful teachers who lectured and assigned worksheets over difficult scientific concepts. Other studies also reported both positive and negative experiences in the secondary and college years (Bulunuz & Jarrett, 2010; Jarrett, 1999; Sutton et al., 1993; Watters & Ginns, 1995). It appears this group of preservice elementary teachers, like those in other studies, had a mixture of both positive and negative experiences in secondary school and college science classes.

A third commonality across the groups was the descriptions of good versus bad science days, as well as good versus bad science teachers. Descriptions of good science days and good science teachers involved teachers who were patient while students worked in groups completing hands-on activities that applied to the real world. Descriptions of bad science days and bad science teachers involved teachers who could not connect to their students while they lectured and students did book work. These descriptions support other studies in which preservice teachers describe positive experiences with lab activities and negative experiences with bookwork (Gauthier, 1994; Talsma, 1997; Watters & Ginns, 1995).

Differences emerged when comparing the four groups of preservice elementary teachers. One difference seems to stem from the people that influenced their attitudes toward science. It appears that the majority of experiences described by Groups 2 (*Low/High*) and 4 (*Low/Low*) were negative influences; whereas Groups 1 (*High/High*) and 3 (*High/Low*) had more positive influences. These findings support those found by Ramey-Gassert et al. (1996) in that those with lower PSTE subscale scores typically had negative experiences with science and those with higher PSTE subscale scores had more positive experiences with science.

Another difference was the types of experiences from elementary school, when they were remembered. It seems that the elementary school science experiences for Groups 1 (*High/High*), 2 (*Low/High*), and 4 (*Low/Low*) were a mixture of positive and negative experiences; whereas Group 3 (*High/Low*) had mostly positive experiences. These findings support those found by Jarrett (1999) in that it appears a positive experience in elementary school leads to increased interest in science. Yet, it appears that these experiences had a mixed effect on the images preservice elementary teachers depicted. Those groups with a mixture of positive and negative experiences depicted both teacher-centered and student-centered classrooms.

A third difference between the groups was their visions of future classrooms. The majority of preservice elementary teachers from all groups shared similar visions of their future classrooms, except for a couple of preservice elementary teachers from Group 2

(*Low/High*) who were not comfortable with the idea of teaching science at all. Aside from those two preservice elementary teachers, the majority envisioned a science classroom where students were working with each other in hands-on activities that applied to real-world situations, much like their positive experiences and descriptions of good days in science. These visions support the findings by Ramey-Gassert et al. (1996) and Thomas and Pedersen (2003) in that preservice elementary teachers typically want to replicate their positive experiences and change their negative experiences in order to provide their future students with a better experience.

Through this mixed methods study, the relationship between perceived science teaching ability, past science experiences, and preservice elementary teachers' perceptions toward science teaching and learning appears to be complex. Looking at Bandura's (1977) sources that influence self-efficacy, it would appear that having positive experiences with science, not necessarily mastery of the experiences, leads to higher levels of self-efficacy for this group of preservice elementary teachers. Additionally, negative experiences with science seem to increase the levels of anxiety towards and avoidance of science which in turn may lead to lower levels of self-efficacy. By utilizing a mixed methods approach, preservice elementary teachers were able to describe in their own words their experiences and perceptions of science, which then were connected back to their scores on the STEBI-B and DASTT-C.

Implications

By examining preservice elementary teachers' levels of perceived science teaching self-efficacy, visions of future classrooms, and past experiences with science, researchers can better understand the role science teaching and learning play in the past, present, and future lives of preservice elementary teachers. The findings of this present study have implications for science teacher educators, classroom teachers, and school administrators.

Science Teacher Educators

Science teacher educators are those responsible for preparing future science teachers. As part of their science methods course, it is important for preservice elementary teachers to have an opportunity to analyze their experiences with science and the potential influence that those experiences bring. In addition, they should examine their levels of science teaching self-efficacy and how their past experiences may have played a role in their development. According to Knowles and Holt-Reynolds (1991), preservice elementary teachers use their past experiences as guidelines for “good” teaching. In addition, Rosenthal (1991), Ellsworth and Buss (2000), and Koch (2010) all argue that autobiographies are useful for preservice elementary teachers to identify their current attitudes toward science and identify where their current attitudes toward science originated.

After science teacher educators identify preservice elementary teachers’ attitudes toward science, they can modify the science methods course to address those attitudes (Ginns, et al., 1995). Researchers express the importance of providing preservice elementary teachers with examples of inquiry-based science that illustrate activities and processes of science that their future students will experience (Jesky-Smith, 2002; Rosenthal, 1991). Further, researchers suggest providing preservice elementary teachers with opportunities to teach each other, as well as classroom students, as a part of their science methods course, so that they can experience a variety of teaching styles (Cantrell et al., 2003; Rosenthal, 1991; Tosun, 2000; Yuruk, 2011). If these science activities and science teaching experiences are positive, they are thought to increase preservice elementary teachers' beliefs in their perceived ability to teach science (Yuruk, 2011).

Elementary Classroom Science Teachers

The results of this study also have implications for elementary classroom science teachers. It is important for this particular group of science teachers to understand the role teachers play in shaping student attitudes toward science in either positive or negative ways (Jarrett, 1999; Sutton et al., 1993; Talsma, 1997; Thomas et al., 2001). Preservice elementary teachers from this study described specific teachers that influenced their attitudes and perceptions of science, both positively and negatively. Positive teacher influences included those whose teachers motivated the students by sharing their love of science and sparking an interest in science (Heather, 5-6; Jane, 10-11; Jennifer, 3-5). Negative teacher influences included those whose teachers were ineffective as a teacher which led to unpleasant experiences in science (Melody, 1-4; Susan 30-31). Using these descriptions as a guide, elementary teachers can begin to understand the level of influence they have on their students, some who might become future teachers, in relation to science teaching and learning.

Elementary teachers provide students with their first encounters with formal science and these experiences lay the foundation for future science classes. In the case of preservice elementary teachers, their elementary school years provide models of teaching they may use in the future. As a result, it is important for elementary teachers to provide positive science experiences for their students. These experiences should include hands-on, inquiry-based activities that can provide examples that future preservice elementary teachers can use (Ellsworth & Buss, 2000; Knowles & Holt-Reynolds, 1991; Talsma, 1997). Many preservice elementary teachers from this study mentioned a connection between their idea of good science days and hands-on activities, whether or not they could remember elementary school science.

School Administrators

Finally, the results from this study have implications for school administrators who are responsible for implementing curriculum policy guidelines in K-12 classrooms. It is important for school administrators to understand the value of science in the elementary classroom and the role science plays in society, including the development of a scientifically literate society (AAAS, 1993; Rutherford & Ahlgren, 1990). Children's experiences with science in the elementary school set the foundations for their attitudes toward science that can carry on into future science classes.

Once school administrators understand the value of science in the elementary classroom, they should encourage, and provide, classroom teachers opportunities to participate in professional development for science instruction. In-service elementary teachers may not be professionally equipped to enact standards-based science instruction due to their own attitudes and preconceptions toward science. Therefore, professional development can provide in-service elementary teachers with opportunities to explore attitudes and preconceptions of science teaching and learning and equip them with instructional strategies for implementing hands-on, inquiry-based science instruction.

Limitations

One limitation to this study was the number of participants. Since the study was conducted at one university and with only one semester of preservice elementary teachers, the researcher was limited in the number of participants used for study. As such, any results are only applicable to this particular group of preservice elementary teachers and are not generalizable to all preservice elementary teachers.

Future Research

The study of preservice elementary teachers and their perceptions of science teaching and learning have been examined in many studies. Yet the findings from these past studies, as well as this current study, yield conflicting results. Specifically, there are conflicting results regarding the effects of a science methods course on STEBI-B scores and the relationship between PSTE subscale scores and DASTT-C images. It appears there needs to be a continued study of preservice elementary teachers before, during, and after their science methods course.

Multiple studies have conducted both pre- and post-tests to assess preservice elementary teachers' perceptions of science teaching and learning, but they also need to be followed throughout their student teaching and first years of classroom teaching. As part of their student teaching and first year of classroom instruction, preservice elementary teachers face unique and different challenges, such as becoming accustomed to teaching on their own for the first time and the responsibilities therein. These new challenges have the potential to further influence their perceptions of science teaching and learning and need to be examined. For example, what is the difference between teaching in a self-contained classroom (all subjects taught by one teacher) versus teaching in an elementary science specific classroom on elementary teachers' perceptions of science teaching and learning?

Another possible avenue for future research could be other formal science settings such as high school and college classes. Since these preservice elementary teachers indicated an increase in negative experiences overall as they progressed from elementary to secondary to college, what modifications could be made to the curriculum? Specifically, how could instructors avoid lectures only to large classes or present material in varied methods? Also, are these increases in negative experiences exclusive to preservice elementary teachers?

As part of this continued examination of science experiences, it is important to add in-depth interviews with participants. In-depth interviews have occurred in some, but not all studies examining preservice elementary teachers. Through these in-depth interviews, the preservice elementary teachers can provide further insight into their past experiences, as well as current challenges and their potential influence on perceptions of science teaching and learning. These interviews can be used throughout teacher preparation programs and into the early years of teaching, to continually provide feedback for science methods instructors and elementary teachers for modified instruction in the science methods course and elementary classrooms.

Summary

The purpose of this study was to examine the science learning experiences and potential influence that these experiences had on preservice elementary teachers' perceptions of science teaching and learning. Findings from the first phase indicate that preservice elementary teachers have a higher level of belief of their perceived abilities to teach science than to affect student outcomes in science. Analysis of the DASTT-C scores indicates a slight majority of these preservice elementary teachers depicted classrooms that were not classified as student-centered. Correlational analysis indicated a very low, positive correlation ($r = .057$) between PSTE subscale and DASTT-C that was not statistically significant at the $p = 0.05$ level. Based on the low Cronbach's alpha value for the STOE subscale, the researcher modified the selection matrix to represent the high and low groups for both the PSTE sub-scale and the DASTT-C.

Findings from the second phase indicate several commonalities and differences between the four groups of the selection matrix. The commonalities across the groups are: (a) the difficulty in remembering science from elementary school; (b) the occurrence of what appears to be a mixture of positive and negative experiences in secondary school and college science classes; and (c) the descriptions of good versus bad days in science, as well as good versus bad science teachers. The differences across groups are: (a) people that influenced attitudes toward science (groups with low PSTE subscale scores reported more negative influences and groups with high PSTE subscale scores reported more positive influences); (b) the types of experiences, when remembered, from elementary school (the group with high PSTE subscale/low DASTT-C scores reported mostly a positive experience); and (c) the visions of their future classrooms (all but two preservice elementary teachers shared similar visions).

Based on these findings, there appears to be a relationship between past experiences and preservice elementary teachers' perceptions toward science teaching and learning. These preservice elementary teachers used their past experiences with science as a foundation for how they perceived science and its instruction in the elementary classroom. Overall, it appears preservice elementary teachers have a desire to make the elementary experience a positive one for their future students and seek to gain the instructional methods necessary to ensure the occurrence of those positive experiences. Those individuals who play a role in elementary education, including science teacher educators, in-service elementary teachers, and school administrators, need to be aware of the relationship between preservice elementary teachers' experiences with science and their perceptions toward science teaching and learning. It is imperative for these individuals to ensure positive science experiences for their students and provide role models for future science instruction.

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APPENDICES

APPENDIX A: STEBI-B (ENOCHS & RIGGS, 1990) MODIFIED BY BLEICHER (2004)

Please indicate the degree to which you agree or disagree with each statement below by placing circling the appropriate letters to the right of each statement. (SA= STRONGLY AGREE; A = AGREE, UN = UNCERTAIN, D = DISAGREE, SD = STRONGLY DISAGREE.)

1	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2	I will continually find better ways to teach science.	SA A UN D SD
3	Even I try very hard, I will not teach science as well as I will most subjects.	SA A UN D SD
4	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5	I know the steps necessary to teach science concepts effectively.	SA A UN D SD
6	I will not be very effective in monitoring science experiments.	SA A UN D SD
7	If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
8	I will generally teach science ineffectively.	SA A UN D SD
9	The inadequacy of a student's science background can be	SA A UN D SD

	overcome by good teaching.	
10	The low science achievement of students cannot generally be blamed on their teachers	SA A UN D SD
11	When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12	I understand science concepts well enough to be effective in teaching elementary science	SA A UN D SD
13	Increased effort in science teaching produces little change in students' science achievement.	SA A UN D SD
14	The teacher is generally responsible for the achievement of student in science.	SA A UN D SD
15	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA A UN D SD
16	If parents comment that their child is showing more interest in science, it is probably due to the child's teacher.	SA A UN D SD
17	I will find it difficult to explain to students why science experiments work.	SA A UN D SD
18	I will typically be able to answer students' science questions.	SA A UN D SD
19	I wonder if I will have the necessary skills to teach science.	SA A UN D SD
20	Given a choice, I will not invite the principal to evaluate my science teaching.	SA A UN D SD
21	When a student has difficulty understanding a science concept, I will usually be at a loss to help the student understand.	SA A UN D SD

22	When teaching science, I will usually welcome student questions.	SA A UN D SD
23	I do not know what to do to turn student on to science.	SA A UN D SD

APPENDIX B: DASTT-C (Thomas et al., 2001)

DASTT-C Instrument

Date: _____________________________ ID #: _____ _____ _____ _____

Location:__________________________ Preservice ( ) or In-service ( )

Draw a picture of yourself as a science teacher at work.

What is the teacher doing? What are the students doing?

____

____

____

____

____

I. TEACHER

Activity

Demonstrating Experiment/Activity ___________________________________

Lecturing/Giving Directions (teacher talking) ___________________________

Using Visual Aids (chalkboard, overhead, and charts) ____________________

Position

Centrally located (head of class) ____

Erect Posture (not sitting or bending down) _____________________________

II. STUDENTS

Activity

Watching and Listening (or so suggested by teacher behavior) ______________

Responding to Teacher/Text Questions___________________________________

Position

Seated (or so suggested by classroom furniture) ___________________________

III. ENVIRONMENT

Inside

Desks are arranged in rows (more than one row) __________________________

Teacher desk/table is located at the front of the room______________________

Laboratory organization (equipment on teacher desk or table) ______________

Symbols of Teaching (ABC's, chalkboard, bulletin boards, etc.) _____________

Symbols of Science Knowledge (science equipment,
lab instruments, wall charts, etc.) ______________________________________

TOTAL SCORE (PARTS I + II + III) =

APPENDIX C: SCIENCE AUTOBIOGRAPHY INSTRUCTIONS

Answer these questions in a 3-4 page paper using a narrative form. Please use 1" margins, 12 point font, and double-space.

1. What is your name?
2. Where were you born?
3. If you know, tell how your parents named you.
4. Name the different places you have lived before now.
5. Tell about your parent(s) degrees and work outside the home.
6. Describe any people or events that influenced your decision to study science.
7. What was elementary school like for you?
    a. What do you remember about science classes?
    b. In what grade do you first remember participating in science in school?
8. What was secondary school like for you?
    a. What do you remember about science classes?
9. What has college been like for you?
    a. Indicate the science classes you have taken and describe your experiences.
10. Describe any personal events (negative and positive events) that have had a major impact on your school life and related science learning.
11. Describe a "good day" in a science class or course.
12. Describe a "bad day" in a science class or course.
13. Distinguish between a "good science teacher" and a "bad science teacher."
14. What role does science play in the elementary school curriculum?
15. What will science teaching and learning look like in your classroom?

APPENDIX D: IRB APPROVAL PAGE

Oklahoma State University Institutional Review Board

Request for Determination of Non-Human Subject or Non-Research

C. Does the study involve access to identifiable private information?
☒ No ☐ Yes

D. Are data/specimens <u>received</u> by the Investigator with identifiable private information?
☒ No ☐ Yes

E. Are the data/specimen(s) coded such that a link exists that could allow the data/specimen(s) to be re-identified?
☐ No ☒ Yes
If "*Yes,*" is there a written agreement that prohibits the PI and his/her staff access to the link?
☐ No ☒ Yes

6. Signatures

Signature of PI Melissa Hulings **Date** 1-28-13

Signature of Faculty Advisor Toni Ivey **Date** Jan 28, 2013
(If PI is a student)

☒ Based on the information provided, the OSU-Stillwater IRB has determined that this project **does not** qualify as human subject research as defined in 45 CFR 46.102(d) and (f) and **is not subject to oversight by the OSU IRB.**

☐ Based on the information provided, the OSU-Stillwater IRB has determined that this research **does** qualify as human subject research and **submission of an application for review by the IRB is required.**

[signature]
Dr. Shelia Kennison, IRB Chair

2/1/13
Date

Revision Date: 04/2006 5 of 5

VITA

Melissa Rene' Hulings

Candidate for the Degree of

Doctor of Philosophy

Thesis: LOOKING BACK AND MOVING FORWARD: A MIXED METHODS STUDY OF ELEMENTARY SCIENCE TEACHER PREPARATION

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Education:
Completed the requirements for the Doctor of Philosophy in Professional Education Studies in Science Education at Oklahoma State University, Stillwater, Oklahoma in May, 2013.

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Completed the requirements for the Bachelor of Science in Secondary Science Education at Oklahoma State University, Stillwater, Oklahoma in 2002.

Experience:
Graduate Research/Teaching Associate, Oklahoma State University, August 2010 to July 2013
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8th Grade Science Teacher, Union Public Schools, Tulsa, Oklahoma, August 2008 to May 2010
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7th-12th Grade Science Teacher, Boynton-Moton Public Schools, Boynton, Oklahoma, August 2002 to May 2005

Professional Memberships:
National Science Teachers Association
School Science and Mathematics Association
Association of Science Teacher Educators
Kappa Delta Pi International Honor Society in Education
Golden Key National Honor Society