THE RELATIONSHIP BETWEEN EPISTEMOLOGICAL BELIEFS AND ATTITUDES
TOWARDS SCIENCE OF UNDERGRADUATE ELEMENTARY EDUCATION MAJORS

by

Renae Reimer Bullock

Liberty University

A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

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2018
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ABSTRACT

Much of the educational research that has investigated the attitudes of pre-service elementary educators towards science has seemed to show that their attitudes are negative towards science. Research also indicates that factors of gender, perceived competence, anxiety, perceived relation to their lives, and epistemological beliefs are related to pre-service elementary educators’ attitudes towards science. The purpose of this study is to investigate the relationship between epistemological beliefs of undergraduate elementary education majors at a large, private, faith-based university in the southeastern United States and their attitudes towards science. Schraw’s Epistemological Beliefs Inventory (EBI) (Schraw, Bendixen, & Dunkle, 2002) was used to measure the epistemological beliefs of undergraduate elementary education majors. Cobern’s Thinking About Science Survey Instrument-v2 (TSSI-v2) (Cobern, 2005) was used to measure attitudes toward science. A random convenience sample of residential, full-time undergraduate elementary education majors of traditional age (under 25 years of age) was obtained. A quantitative correlation design was used for this study. Spearman’s rho statistical test was used to test the hypotheses.

Keywords: epistemological beliefs, attitudes towards science
Dedication

This dissertation is dedicated to my dad, Dr. Milton Reimer, professor emeritus from Liberty University. His steadfast love and patience have always been to me a picture of God the Father. His encouragement and the assurance of his prayers and interceding to the throne of God on my behalf have given me the courage to walk through each situation that life has brought my way.

Dad, I always have and always will love you.
Acknowledgements

I would like to thank the many that have contributed to my reaching of this goal.

Thank you to my colleagues who stopped by my office and stopped me in the hall to ask how I was progressing and to offer their words of wisdom.

Thank you also my parents, Milton and Clarice Reimer for their love, support, and especially the prayers that I know were going up for me daily and often many times a day.

Thank you to my husband, Cley, and our three sons, Ryan, Timothy and Tyler for their unwavering support and encouragement throughout the many years of this process. They each made many sacrifices along the way in order for me to be able to spend the necessary time to accomplish this task.

Thank you to my committee member, Dr. William Cobern. His expertise in the area of my study was an invaluable source in my endeavors. I am grateful to him for accepting my request to be on my committee and for challenging my thought processes.

Thank you to my dissertation chair, Dr. Rebecca Lunde, for her encouragement, patience and incredible guidance. Many is the time that I was frustrated, in despair, and at a standstill when she calmly and cheerfully lifted me up, dusted me off, and got me back on track again.

And with the utmost gratefulness and thankfulness I thank God the giver of “every good and perfect gift” (James 1:17, KJV) who has blessed me “exceeding abundantly above all that [I could] ask or think” (Eph. 3.20, KJV).
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List of Abbreviations

Christian Fundamentalist Belief Scale (CFBS)
Cobern’s Thinking About Science Survey (TSSI)
Cobern’s Thinking About Science Survey-v2 (TSSI-v2)
Epistemology (EPIST)
Individual recommendation plan (IRP)
Informal science experiences (ISE)
International Review Board (IRB)
Outcome belief efficacy (OBE)
Personal science teaching efficacy (PSTE)
Personal self-efficacy (PSE)
Public policy and science (POLY)
Research experiences for teachers (RETs)
Questionnaire on Teacher Interaction (QTI)
Schommer’s Epistemological Beliefs Questionnaire (EBQ)
Schraw et al.’s Epistemological Beliefs Inventory (EBI)
Science and the economy (ECON)
Science and the environment (ENVIR)
Science and public health (HEAL)
Science, emotions and aesthetics (BEAUT)
Science for all (For_All)
Science, race and gender (RACE)
Science, religion and morality (RELIG)
Science teaching outcome expectancy (STOE)

Social Cognitive Theory (SC)

Teachers’ Attitude Towards Teaching Science (TATTS)

Teacher design teams (TDT)

Test of Science Related Attitudes (TOSRA)

Triadic reciprocal determinism (TRD)
CHAPTER ONE: INTRODUCTION

Overview

The purpose of this study was to determine the relationship between the dimensions of epistemological beliefs of undergraduate elementary education majors and their attitudes towards science. This was done by replicating previous research that investigated the relationship between epistemological beliefs and attitudes towards science done by Fulmer (2014). Chapter One discusses the background related to the importance of positive attitudes towards science and the factors that affect those attitudes. The discussion is narrowed down to the importance of the factor of epistemological beliefs to attitudes towards science and the current studies done in this area. Fulmer’s study on epistemological beliefs and attitudes towards science is examined with areas of improvement and clarification for further study identified and discussed for the present study. Following the background of this study the purpose and significance of the study is indicated and the research question is stated. Chapter One ends with the definitions of important and key words and terms to this study.

Background

In 1975, Gardner stated that “the volume of research on attitudes in the field of science education has grown so large that it is no longer possible to produce a comprehensive and detailed review of the literature within the confines of a journal article” (p. 2). Now, 32 years later, that volume is even more extensive. A summary review of this extensive volume of research on attitudes indicated that along with other factors such as gender, home environment, and parental achievement (Schibeci & Riley, 1986), students’ attitudes towards education in general are linked to their achievements in school (Daviran, 2014; Mojavezi & Tamiz, 2012; Osborne, Simon & Collins, 2003; Tai, Liu, Maltese, & Fan, 2006). Daviran (2014) stated that
“If the student and teacher attitudes towards the education will be weak, the students will have problems in their academic success” (p. 404). Specifically in the area of science, students’ attitudes towards science have long been linked to their achievements in science (Harty, Beall, & Scharmann, 1985; Schibeci & Riley, 1986), with continuing indication in more recent studies (Odom & Bell, 2015; Tai et al., 2006). Research has also shown that students’ attitudes towards science are a key factor in the choosing of courses and careers in science (Rice et al., 2013). Because it is recognized that elementary and middle school years are formative years for the development of attitudes towards science (Young, 1998), much of the research done in the area of the attitudes towards science has been done on this age group (Ali, Yager, Hacieminoglu, & Caliskan, 2013; Hough & Piper, 1982; Kapici & Akcay, 2016; Schibeci & Riley, 1986). Young (1998) said that “positive attitudes must be formed during a student’s primary and secondary school career. This, in turn, relies on teachers themselves having a positive attitude towards this area of the curriculum” (p. 107). Unfortunately, research done on these age groups has indicated that attitudes of students towards science decline as they progress from elementary to middle to high school (Ali et al., 2013; Kapici & Akcay, 2016), which results in a decrease of young people pursuing careers in science (George & Kaplan, 1998; Hillman, Zeeman, Tilburg, & List, 2016).

Of continuing concern, then, is determining the factors that contribute to the attitudes that students, and particularly elementary and middle school students, have towards science. Although this is a continuing area of research, it is not new. Research has long indicated that teachers’ attitudes and self-efficacy affect students’ attitudes and achievement (George & Kaplan, 1998), and has continued to more recent studies (Ambusaidi & Al-Farei, 2017; Blazar & Kraft, 2017; Boonen, Van Damme & Onghena, 2014; Britner & Pajares, 2006; Mohamadi &
Asadzadeh, 2012; Mojavezi & Tamiz, 2012). Specifically related to the area of science, research has also indicated that teachers’ attitudes towards science are related to the attitudes that elementary and middle school students have towards science (Ahmad & Rehman, 2014; Britner & Pajares, 2006). In a study done by Urey and Cerrah Ozsevgec (2016), it was shown that elementary science teachers and their students have similar misconceptions about science, showing the impact that elementary teachers have on their students. Osborne et al. (2003) stated that “the single most important change that could be made to improve the quality of science education would be the recruitment and retention of able, bright, enthusiastic teachers of science” (p. 1069).

Unfortunately to the relationship between students’ attitudes towards science and their teachers’ attitudes towards science, research had also indicated that, typically, elementary educators already in the field (Pendergast, Lieberman-Betz, & Vail, 2017) and pre-service elementary educators’ (Bleicher, 2007; Kenny, 2010; McDonnough & Matkins, 2010; Young, 1998) have negative attitudes towards science.

A survey of research also indicated that elementary educators have low confidence in their ability to teach science (Avery & Meyer, 2012; Cobern & Loving, 2002) and perform laboratory experiments (Bayraktar, 2011). Lack of confidence and negative attitudes will affect the way in which educators conduct themselves in their classrooms and ultimately the attitudes of their students towards science (Ahmad & Rehman, 2014; Britner & Pajares, 2006), so it is important to identify factors that influence their attitudes. Interestingly, although the weight of the research seems to indicate that pre-service elementary educators have negative attitudes towards science, this does not extend to how they “value” science. In a study done by Cobern and Loving (2002) the “value” that pre-service educators placed on science rather than in their
“feelings” towards science was investigated using Cobern’s Thinking about Science Survey (Cobern & Loving, 2002), an “anti-science sentiment” among lay or pre-service elementary educators was not indicated (p. 1027). On the other hand, Fulmer (2014) used Cobern’s (2005) Thinking About Science Survey instrument—v2 (TSSI-v2) but used attitudes towards science as a “feeling” rather than a “valuation”. He concluded that students had negative attitudes towards science if they perceived it as being religious.

Research has shown many factors that affect pre-service elementary educators’ attitudes towards science (Riegle-Crumb, Morton, Moore, & Chimonidou, 2015; Senler, 2016). This is by no means a new problem. Morrisey (1981) noted that programs developed in the 60s and 70s for teaching science were no longer being implemented in schools. He attributed this to elementary educators’ attitude towards science. He said that “It seems reasonable to assume that achieving a positive attitude toward science on the part of elementary student teachers is the logical first step toward ensuring that they are open to acquiring a positive attitude toward teaching science” (p. 158). Research indicates that preservice elementary educators are weak with regard to their science content backgrounds (Bleicher & Lindgren, 2005; McDonnough & Matkins, 2010) which leads to low self-efficacy towards their knowledge and ability and then contributes to a negative attitude towards teaching science. A qualitative study done by Katz, McGinnis, Riedinger, Marbach-Ad, and Dai (2013) indicated that for the elementary teachers researched, the fear of teaching science was attributed to their own past negative experiences in science. A study done by Urey and Cerrah Ozsevgec (2016) suggested that not recognizing that a scientific concept is related to real life, or how it is related to real life, negatively affected pre-service elementary educators’ attitudes towards science. In another study done by Sundberg and
Ottander (2013), results suggested that the expectations of the teacher towards the science content curriculum was not clear and that this led to low self-efficacy and negative attitude.

Research has indicated a number of factors that are positively related to the attitudes that pre-service elementary educators have towards science. A factor that was indicted to positively affect the attitudes of pre-service elementary teachers towards science was certain types of courses included as part of their education program. Shown to affect students positively are inquiry-based science content courses (Riegle-Crumb et al., 2015). Similarly, it was found in a literature review that activity-based, hands-on, field-oriented methods courses resulted in increased positive attitudes towards science (Morrisey, 1981). Also, research indicates that informal science education (ISE) programs increase the positive attitudes towards science (Katz et al., 2013).

Epistemology is “an area of philosophy concerned with the nature and justification of human knowledge” (Hofer & Pintrich, 1997, p. 88). Early studies done on epistemological beliefs focused on the way in which the beliefs developed. In a report to the Department of Health, Education and Welfare, Perry (1968) described the results of research that he had conducted over the course of four years on students in undergraduate studies from Harvard University. In his report he concluded that it was possible to assess development of aspects of knowing and valuing and his research confirmed the validity of one scheme of development, or that epistemological development is unidimensional (Perry, 1968). Later studies showed epistemology to be multi-dimensional (Schommer, 1990; Schraw et al., 2002). Epistemological beliefs were then examined as to their effects on learning (Cheng, Cheng, Chan & Tang, 2009; Kilinc & Seyman, 2014; Liu & Tsai, 2008; Phan, 2008; Schommer, 1990). Research has found epistemological beliefs to be related to learning and academic performance (Phan, 2008),
comprehension (Schommer, 1990), views of science (Liu & Tsai, 2008), innate learning and choosing science as a career (Kilinc & Seyman, 2014), conceptions of teaching (Cheng et al., 2009), and self-efficacy beliefs (Yilmaz-Tuzun & Topcu, 2008).

In 2014, Fulmer investigated the relationship between the epistemological beliefs of undergraduate students at a large, public university in the eastern United States and their attitudes towards science. The study was based on the lay epistemic theory which posits that knowledge is a form of belief and that it is continually developing. Fulmer (2014) used Schraw et al.’s (2002) Epistemological Belief Inventory (EBI) to measure the students’ epistemological beliefs and Cobern’s (2005) Thinking About Science Survey Instrument-v2 to measure the students’ attitudes towards science. Results of Fulmer’s (2014) study indicated that attitudes towards science were positively related to authority and non-religious aspects of science and negatively related to certainty aspects of science. From the data, Fulmer (2014) concluded that students have more positive attitudes towards science when they believe that knowledge can be derived from authority, is inclusive of women and minorities, and is non-religious and that students’ attitudes towards science are more negative if they believe that knowledge is certain (Fulmer, 2014).

Framing the present study is the social cognitive theory (CT) that was developed by Bandura in 1986. The CT is built around the construct of self-efficacy which is defined by Bandura (1997) as “beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave” (p. 71). In this investigation of how epistemological beliefs are related to attitudes towards science it is recognized based on Bandura’s social cognitive theory, that some aspect of elementary educators’ environment,
experiences, and beliefs affect their attitudes. On the other hand, with a slight shift in paradigm, the social cognitive theory describes not merely a rote or reflex reaction to a stimulus but the ability that a person has to alter actions or change the circumstances that can lead to a different outcome (Bandura, 2001). In this study, the ability to alter actions or change circumstances allows for studying and researching the factors that affect attitudes towards science with the intent to provide information that will allow for a change in a stimulus for elementary education majors and therefore alter the outcome of a negative attitude towards science.

**Problem Statement**

Literature has addressed many factors that affect teachers’ attitudes towards science and towards teaching science (Fulmer, 2014; Katz et al., 2013; Riegle-Crumb et al., 2015; Urey & Cerrah Ozsevgec, 2016). Less studied has been the relationship between epistemological beliefs, beliefs about the nature and the source of knowledge, and attitudes towards science (Fulmer, 2014). In an examination of epistemological theories and studies that include it as a variable, Hofer and Pintrich (1997) said:

In all this research there is very little agreement on the actual construct under study, the dimensions it encompasses, whether epistemological beliefs are domain specific or how such beliefs might connect to disciplinary motivation. (p. 89)

There are, however, recent studies that have indicated that epistemological beliefs are a factor in attitudes towards science. Cheng et al. (2009) found that epistemological beliefs affected the way in which pre-service teachers teach. Yilmaz-Tuzun and Topcu (2008) found that in a population of pre-service science educators certain aspects of epistemological beliefs and self-efficacy were related. Fulmer (2014) found that epistemological beliefs of
undergraduate students at a large, public university in eastern United States were related to their attitudes towards science.

Using the lay epistemic theory which posits that knowledge is a form of belief and that it is continually developing, as the basis of the study, Fulmer (2014) used Schraw et al.’s (2002) Epistemic Belief Inventory and Cobern’s (2005) Thinking about Science Survey Instrument-v2 to investigate the relationship between epistemological beliefs and attitudes towards science of undergraduate students at a large, public university in the eastern United States. In the study, Fulmer created a category called “non-religious” based on a “perceived discrepancy between scientific and religious knowledge, such as ‘Science is more important source of knowledge than religion’” (Fulmer, 2014, p. 202). There were two noted problems with the creation of this category; that the category was not validated nor was the intended use of Cobern’s TSSI-v2 and that it was created without accurately determining the religiosity of the participants in the study as being religious or non-religious. Additionally, Fulmer (2014) defined attitudes as the “positive or negative opinions that individuals have about science, based on their perceptions of science” (p. 200). However, Cobern’s intended use for the TSSI-v2 is as a measurement of the “valuation of science” (Cobern, Loving, Davis, & Terpstra, 2013, p. 408). Moreover, in a study conducted by Cobern et al. (2013) that examined the valuation of science among participants that held orthodox Christian views as measured by Gibson and Francis’ (1996) Christian Fundamentalist Beliefs Scale, it was concluded that:

There is no empirical corroboration for the suggestion that support for science is negatively associated with Christian orthodoxy or even Christian fundamentalism—hence, no empirical support for the suggestion that science and being a Christian are incompatible. (p. 498)
Finally, Fulmer (2014) incorrectly used Cobern’s TSSI-v2 by using it to study the relationship between two factors. Cobern (2005) said that the TSSI “should be useable in studies that compare the ideas held by different groups” (p. 49).

The problem is that in contributing to the literature on how epistemological beliefs affect elementary educators’ attitudes towards science, there are enough discrepancies in Fulmer’s (2014) study to warrant a replication of the study. This study used a population of undergraduate elementary education majors from a large, private, faith-based university as participants. This provided a demographic makeup that is significantly different than the demographic makeup of that studied in the public university. To clearly identify the religious identity of the participants in this study, the Christian Fundamentalist Beliefs Survey (Gibson & Francis, 1996) was administered. To align with Cobern’s intended definition for attitudes towards science in development of the TSSI and TSSI-v2 (Cobern, 2005; Cobern & Loving, 2002; Cobern et al., 2013), “attitudes towards science” will have the meaning of “valuation of science”.

**Purpose Statement**

The purpose of this quantitative correlation design study was to examine the relationship between the epistemological beliefs of undergraduate elementary education majors at a large, private, faith-based university in the southeastern United States and the dimensions of their epistemological beliefs. This was be done by replicating the study done by Fulmer (2014) in which the relationship between epistemological beliefs of undergraduate students at a large, public university in the eastern United States and their attitudes towards science was investigated. A review of Fulmer’s (2014) investigation into the way in which epistemological beliefs of undergraduates in a large, public university in the eastern United States are related to their attitudes towards science, showed discrepancies that this study adjusted for. In Fulmer’s
study, a “non-religious” category was created based on the TSSI-\textit{v2} statement “Science is a more important source of knowledge than religion” (Fulmer, 2014, p. 202). This arbitrary categorization was not the intent of the questionnaire, was not validated in the development of the instrument, nor was it backed up with data from studies that test religiosity (Cobern et al., 2013). Additionally, the religiosity of the students was not confirmed in creating this category and placing students in it. In this study, an additional scale was used to test the religiosity of the participants in the study. Fulmer’s (2014) suggestion for further study was to extend the study to other populations. This study was done using a population of undergraduate elementary education majors in a private, faith-based university in southeastern United States. The population of elementary education majors from which the participants were drawn for this study had different demographics than the previously studied population from a public university and so lent itself to a broader understanding of the role that epistemological beliefs have on science attitudes. The hope and intent was to add to the literature in such a way that would allow university programs to improve pre-service elementary educators’ attitudes towards science.

In addition, a number of features of Fulmer’s (2014) study were changed to better describe the intent of the author of the TSSI-\textit{v2} with regard to definition of attitude towards science and to the idea of religion or religiosity. These changes were based on using a definition of attitudes in science that has to do with valuation of science as intended by Cobern (2005), taking out the non-religious category included in Fulmer’s (2014) study but not validated in either of the instrument developments, and using a validated religiosity scale to determine the religiosity of the participants.

This study used a population of residential, full-time, elementary education majors from which to cull participants. A convenience sample was used as participants from this population.
The study was done using three questionnaires. Schraw et al.’s (2002) Epistemological Belief Inventory was used to test the predictor variables, dimensions of epistemological beliefs. Epistemological beliefs are defined generally as the theories and beliefs that a person holds about knowing (Hofer & Pintrich, 1997; Schommer, 1990). Cobern’s Thinking About Science Survey Instrument-version 2 (Cobern, 2005) was used to test the criterion variable, attitudes towards science. Attitudes towards science is generally defined as “feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves” (Osborne et al., 2003, p. 1053) or as beliefs about science, students, and science teaching and learning (Kazempour, 2014) and is the definition used by Fulmer (2014). However, in this study, attitudes towards science takes on the meaning intended by Cobern (2005), which is to “illuminate the balance and valuations people hold about science in the context of several other culturally and socially – but not scientific per se – important issues” (Cobern, 2001, p. 49). That is, attitudes towards science in this study was defined as how elementary education majors value science in context of the common, popular view of science. To test the religiosity of the participants in this study, the Christian Fundamentalist Belief Scale (Gibson & Francis, 1996) was administered. Religiosity is defined as a religious commitment (Manwaring, Jensen, Gill, & Bybee, 2015) or religious behavior; such as Fundamentalism or Mormonism, or the way in which people and communities are “influenced by religious ideas and shape social reality accordingly” (International Encyclopedia of Social Sciences, 2008, p. 162).

**Significance of the Study**

Many studies have shown that pre-service elementary educators have negative attitudes towards science (Bleicher, 2007; Kenny, 2010; McDonnough & Matkins, 2010; Young, 1998). However, there are a number of notable exceptions that indicate that elementary educators do not
have negative attitudes towards science (Cobern et al., 2013; Kirik, 2013). This is a significant point to focus on because research indicates that the attitudes that elementary educators have towards science affect the way in which they teach science (Ambusaidi & Al-Farei, 2017) and ultimately the attitudes and achievements of their students (Bolshakova, Johnson, & Czerniak, 2011). Factors that contribute to attitudes towards science need to be adequately researched in order that education programs can produce educators that are in the best position possible to positively affect their students’ attitudes and achievements (Young, 1998).

In reviewing Fulmer’s (2014) investigation into the way in which epistemological beliefs of undergraduates in a large, public university in the eastern United States are related to their attitudes towards science, a number of discrepancies were noted that this study adjusted for. The study (Fulmer, 2014) was based on the lay epistemic theory which posits that knowledge is a form of belief and that it is continually developing. To determine the epistemological beliefs, Schraw et al.’s (2002) Epistemological Belief Inventory (EBI) was used. To determine attitudes towards science, Cobern’s (2005) Thinking About Science Survey Instrument-v2, was used. In Fulmer’s study, a “non-religious” category was created based on the TSSI statement “Science is a more important source of knowledge than religion” (Fulmer, 2014, p. 202). This arbitrary categorization was not the intent of the TSSI-v2 questionnaire, was not validated in the development of the TSSI instrument, nor was it backed up with data from studies that test religiosity (Cobern et al., 2013). Additionally, the religiosity of the students was not confirmed in creating this category and placing students in it. In this study, the Christian Fundamentalist Belief Scale (Gibson & Francis, 1996) was used to test the religiosity of the participants in the study.
Fulmer’s (2014) suggestion for further study was to extend the study to other populations. This study was done using a population of undergraduate elementary education majors in a private, faith-based university in southeastern United States. The population used in this study is likely to have different demographics than the previously studied population from a public university and so lent itself to a broader understanding of the role that epistemological beliefs have on science attitudes with the hope and intent that adding to the literature in this way will allow university programs to improve pre-service elementary educators’ attitudes towards science.

In addition, a number of features of Fulmer’s (2014) study were changed to better describe the intent of the author of the TSSI-v2 with regard to definition of attitude towards science and to the idea of religion or religiosity. These are using a definition of attitudes in science that has to do with valuation of science as intended by Cobern (2005) and taking out the non-religious category included in Fulmer’s study but not validated in either of the instrument developments.

Research Question

RQ1: Is there a relationship between the dimensions of epistemological beliefs of undergraduate elementary education majors at a private, faith-based university in southeastern United States and their attitudes towards science?

Definitions

1. **Attitude** – Attitude is a psychological tendency that involves evaluating a particular object with some degree of favor or disfavor (Eagly & Chaiken, 1993); powerful psychological factors that affect behavior (Bayraktar, 2011), or a valuation; that is, how a person values an entity or concept (Cobern et al., 2013).
2. **Attitudes towards science (Popular view)**– Attitudes towards science are “feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves” (Osborne et al., 2003, p. 1053); beliefs about science, students, and science teaching and learning (Kazempour, 2014).

3. **Attitudes towards science (Fulmer)** – Attitudes towards science are the “positive or negative opinions that individuals have about science, based on their perceptions of science” (Fulmer 2014, p. 200).

4. **Attitudes towards science (Cobern)** – “The balance and valuations people hold about science in the context of several other culturally and socially – but not scientific per se – important issues” (Cobern, 2001, p. 49).

5. **Determinism** – Part of triadic reciprocal determinism, determinism is “used...to signify the production of effects by certain factors” (Bandura, 1986, p. 23).

6. **Dualistic view of epistemological beliefs** – A dualistic view of epistemological beliefs are views that “see statements about reality as either ‘right’ or ‘wrong’; in case of doubt, experts will be able to provide the correct answers” (Trautwein & Ludtke, 2007, p. 349).

7. **Epistemology** – Epistemology is an area of philosophy that involves nature of knowledge and justification of human knowledge (Hofer & Pintrich, 1997; Phan, 2008).

8. **Epistemological beliefs** – Epistemological beliefs are the theories and beliefs that a person holds about the nature of knowing and knowing (Hofer & Pintrich, 1997; Schommer, 1990).

9. **Epistemological realism** – Epistemological realism is the existence of an external world outside of human perception (Cobern & Loving, 2002).
10. *Epistemological pluralism* – Epistemological pluralism is the recognition that answers about the questions that people have about knowledge can come from various sources (Cobern & Loving, 2007).

11. *Fundamentalism* – Fundamentalism a “construct that combines notions of biblical authority with conservatism in morality and politics, opposition to evolution, millenarianism, evangelicalism and personal assurance of salvation” (Gibson & Francis, 1996, p. 249).

12. *Interest* – Interest is the combination of emotion and personal valuation of a task resulting in a desire for various levels of enjoyment (Ainley & Ainley, 2011).

13. *Informal Science Education* – Informal science education are science courses and programs within typical educational programs that allow the learning and experiencing of science by visiting optional sites (Kisiel, 2013).

14. *Informal Science Education Institutions* – Institutions or events such as field trip destinations, science museums and nature centers, that provide learning environment that is unique and that supports programming for outside interest groups such as elementary educator programs (Kisiel, 2013).

15. *Individual science experiences* – Individual science experiences are science programs that are part of an education program. These programs include features such as alternative choices of reading materials and assessments and other features that allow the pre-service teachers to study aspects of science that are of interest individually (Katz et al., 2013).

16. *Multiplistic view of epistemological beliefs* – Multiplistic views of epistemological beliefs are those in which “different views on reality are accepted” (Trautwein & Ludtke, 2007, p. 349).
17. *Naïve epistemological beliefs* – “personal epistemology is a belief system that is composed of several more or less independent dimensions” (Schommer, 1990, p. 498).

18. *Outcome Belief Efficacy* – Outcome belief efficacy is a judgment of the likely consequence that a certain level of performance will produce (Bandura, 1986).

19. *Perceived (Personal) Self-efficacy* – Perceived (personal) self-efficacy is a “judgment of one’s capabilities to accomplish a certain level of performance” (Bandura, 1986, p. 391).

20. *Reciprocal* – Part of triadic reciprocal determinism, reciprocal refers to the “mutual action between causal factors” (Bandura, 1986, p. 23).

21. *Religiosity* – Religiosity is religious commitment (Manwaring et al., 2015) or religious behavior; such as Fundamentalism or Mormanism, or the way in which people and communities are “influenced by religious ideas and shape social reality accordingly” (International Encyclopedia of Social Sciences, 2008, p. 162).

22. *Relativistic view of epistemological beliefs* – A relativistic view of epistemology holds that “all knowledge is seen as a human construction that is uncertain and might be proven wrong; no one approach can be construed as superior to another” (Trautwein & Ludtke, 2007, p. 349).

23. *Research Experiences for Teachers* – Research experiences for teachers are a form of professional development that focuses on teachers’ performing research as a way to increase positive attitudes and classroom practices (Enderle et al., 2014).

24. *Self-Efficacy* – Self-efficacy is the “Generative capability in which cognitive, social, and behavioral subskills must be organized into integrated courses of action to serve innumerable purposes” (Bandura, 1986, p. 391).
25. *Sense of efficacy* – A sense of efficacy for teachers is a judgment about their abilities to influence the engagement and learning of their students, even among those who are difficult and/or unmotivated (Hoy & Davis, 2006).

26. *Sophisticated epistemological beliefs* – Sophisticated epistemological beliefs are beliefs that knowledge is uncertain. “All knowledge is seen as a human construction that is uncertain and that might be proven wrong; no one approach can be construed to be superior to another” (Trautwein & Ludtke, 2007, p. 349).

27. *Teacher Design Teams* – Teacher design teams are profession development programs designed to improve science content knowledge and pedagogical practices by interaction with members of a team and by designing and implementing curriculum changes (Velthuis, Fisser, & Pieters, 2015).
CHAPTER TWO: LITERATURE REVIEW

Overview

This chapter starts with a discussion of Bandura’s social cognitive theory and its major construct, self-efficacy, as the theoretical framework on which the study is based. The concepts of epistemology, religion and religiosity, and attitudes towards science are discussed as they relate to the Social Cognitive Theory and to this study. Past and current literature is reviewed on research that has been conducted and results that indicated, 1) that students’ attitudes are related to their achievement and future course of study, 2) that teachers’ attitudes are related to students’ attitudes and achievements, 3) the factors that are related to pre-service elementary educators’ attitudes towards science, and 4) the factor of epistemology, specifically, as it is related to attitudes towards learning and attitudes towards science. Fulmer’s (2014) study on the relationship between epistemological beliefs and attitudes towards science is discussed along with the discrepancies.

Theoretical Framework

Social Cognitive Theory

The theoretical framework that this study is based on is the Bandura’s social cognitive theory. The Social Cognitive theory (SC) is a major and early theoretical framework of learning and behavior. It is often used for research that studies the relationship between environmental factors, science attitudes, and science behaviors (Avery & Meyer, 2012; Kazempour, 2014; Kirik, 2013; Menon & Sadler, 2016; Mohamadi & Asadzadeh, 2012; Mojavezi & Tamiz, 2012). The SC explains how human actions and/or behaviors are learned behaviors that are influenced by personal and environmental variables or factors and by social interactions. (Bandura, 1977b). It explains the relationship with triadic reciprocal determinism (TRD) in which behavior,
environmental influences, and personal factors, such as cognitive factors, all operate to be interactive determinants of each other (Bandura, 1986, p. 23). Thus, each of these three factors work to affect all of the others, making a “multiplicity of interacting influence” (Bandura, 1986, p. 24). A review of literature showed that research indicates a relationship between students’ attitudes towards science and their achievements and future course of study, a relationship between students’ attitudes towards science and their teachers’ attitudes towards science, and a relationship between pre-service teachers’ attitudes towards science and a variety of environmental and personal factors. Each of these relationships can be studied within the framework of Bandura’s Social Cognitive Theory (SC).

Self-efficacy is a key construct in social cognitive theory. In the SC, self-efficacy serves to act upon the other factors involved in the TRD interactions to produce a course of action. It involves a “generative capability in which cognitive, social, and behavioral subskills must be organized into integrated courses of action to serve innumerable purposes” (Bandura, 1986, p. 391). Perceived or personal self-efficacy (PSE) is the “judgement of one’s capability to accomplish a certain level of performance” (Bandura, 1986, p. 391) or the “belief about what one can do under different sets of conditions with whatever skills one possesses” (Bandura, 1997, p. 37). Self-efficacy “will contribute to and draw from the development of skills” (Bandura, 1986, p. 395). Outcome Belief Efficacy (OBE) is based on judgments of how well…(one) “will be able to perform in given situations” (Bandura, 1986, p. 392). People will be more likely to perform an action if they are convinced that their actions will result in a favorable and expected outcome (outcome expectancy) or if they are convinced that they have the ability to perform the action (personal efficacy). Bandura (1977a) explained, “Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and
aversive experiences. The stronger the perceived self-efficacy, the more active the efforts” (p. 194).

The Social Cognitive Theory and the self-efficacy construct have been used as the theoretical framework in the field of education in studies investigating the relationship between self-efficacy and achievement (Hoy & Davis, 2006) and attitude towards science (Kazempour, 2014; Menon & Sadler, 2016), self-efficacy and science understanding, management beliefs, and teaching beliefs (Kirik, 2013), self-efficacy information and students’ achievements (Mahamadi & Asadzadeh, 2012), self-efficacy and science conceptual understanding (Menon & Sadler, 2016), teacher self-efficacy and student motivation and achievement (Mojavezi & Tamiz, 2012).

The Social Cognitive Theory establishes that achievements in science are affected by attitudes. Using SC as a framework, therefore allows the investigation of the factors that affect students’ attitudes towards science. Research indicates that teachers’ attitudes are one of the factors that affect students’ attitudes (Ambusaidi & Al-Farei, 2017; Blazar & Kraft, 2017; Boonen et al., 2014; Britner & Pajares, 2006; Mohamadi & Asadzadeh, 2012; Mojavezi & Tamiz, 2012). Correspondingly, there are factors that affect pre-service elementary educators’ attitudes towards science that have been thoroughly researched (Avery & Meyer, 2012; Katz et al., 2013; Riegle-Crumb et al., 2015; Senler, 2016, Urey & Cerrah Ozsuygec, 2016). One of the factors that research has shown to affect students’ attitudes from elementary through undergraduate college students, including pre-service elementary educators, are their epistemological beliefs (Cheng et al., 2009; Fulmer, 2014; Kilinc & Seymen, 2014).

The necessary actions (behaviors) and positive self-efficacy of educators, particularly elementary educators in the teaching of science, must be that which best promotes achievement, motivation, and interest of their students. Pre-service elementary educators that have attitudes
that science is difficult and that they cannot succeed in teaching it well could result in a behavior of avoiding teaching it.

These behaviors of the educators relative to the area of teaching science have themselves been affected by environmental and social situations from their past educational experiences and from their teacher education programs. It is important to examine these factors that affect the teachers’ behaviors and self-efficacies, so that the best environmental and social situation for pre-service elementary educators can be implemented in their teacher education programs.

**Related Literature**

**Attitudes Towards Science**

Important to this study is exactly what is meant by attitudes towards science. Often mistaken for scientific attitudes, attitudes towards science is a concept distinct from scientific attitudes. Gardner (1975), in an early review of science attitudes, addressed this issue and discusses the difference.

The term ‘attitude’ is a very broad one, and even when it is used in discussions about science education, the term can take on different meanings. It is possible to distinguish two broad categories: *attitudes towards science* (e.g. ‘interest in science’, ‘attitudes towards scientists’, ‘attitudes towards social responsibility in science’) and *scientific attitudes* (e.g. ‘open-mindedness’, ‘honesty’, ‘skepticism’). In the first category, there is always some distinct attitude object (‘science’, ‘scientists’) to which the respondent is invited to react favorably or unfavorably. In the second category, this description is inapplicable: traits such as ‘open-mindedness’ and ‘honesty’ are better described as styles of thinking which scientists are presumed to display. (pp. 1-2)
After distinguishing it from attitudes towards science, there are two ways in which scientific attitudes are viewed. Both Klopfer (1971) and Gardner (1975) distinguished between scientific attitudes and attitudes towards science in their studies and then further distinguished between the popular conception of scientific attitudes and a better working definition. Klopfer (1971) described the popular conception of science attitude as being an attitude of “open-mindedness, honesty, self-criticism, willingness to suspend judgement” (p. 577). Gardner (1975) defined the popular conception of science attitude as being “open-mindedness, honesty and skepticism” (p. 2). Klopfer (1971) noted that scientific attitudes are “better described as professional standards to which adherence by practitioners of scientific inquiry is expected by the scientific community” (p. 578), which are more related to the “reflection of the nature of scientific inquiry and the internal social organization of science than of the personalities of scientists” (p. 577). While Gardner (1975) stated that the description of scientific attitudes are “better described a styles of thinking which scientists are presumed to display” (p. 2). Scientific attitudes are a result of positive attitudes towards science as are other positive behaviors involved with science learning and activities.

Most commonly, when attitudes are used in educational studies it is used as “attitudes towards science” as distinct from “scientific attitudes” (Ambusaidi & Al-Farei, 2017; Blazar & Kraft, 2017; Boonen et al., 2014; Britner & Pajares, 2006; Fulmer, 2014; Mohamadi & Asadzadeh, 2012; Mojavezi & Tamiz, 2012). In keeping with Bandura’s social cognitive theory that attitudes determine behavior, an early definition of attitudes towards science was put forth by Klopfer (1971) who categorized attitudes towards science based on the following set of behaviors in science:
1) the manifestation of favorable attitudes towards science and scientists; 2) the acceptance of scientific enquiry as a way of thought; 3) the adoption of ‘scientific attitudes’; 4) the enjoyment of science learning experiences; 5) the development of interests in science and science-related activities; and 5) the development of an interest in pursuing a career in science or science related work. (pp. 577-578)

Similarly, Gardner (1975) simply defined attitudes towards science as “interest in science” (p. 1), and then went on to say “in which the respondent is invited to react favorably or unfavorably (p. 1). In this way, he linked the manifested behaviors of attitudes towards science with later definitions of attitudes towards science that leant more towards feelings and opinions towards something.

Eagly and Chaiken (1993) provided an “abstract—or—umbrella definition of attitude as a ‘psychological tendency that involves evaluating a particular object with some degree of favor or disfavor’” (p. 1), with the intent to distinguish between the “inner tendency that is attitude from the responses that express attitude” (p. 1). This was backed up later when Bayraktar (2011) defined attitudes as “powerful psychological variables that affect behavior” (p. 84). Applying that definition specifically to attitudes towards science, Osborne et al. (2003) stated that attitudes towards science are “feelings, beliefs, and values (italics mine) held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves” (p. 1053). From these definitions it can be seen that it is hard to separate a definition of attitudes from the resulting behaviors.

Fulmer (2014), in his study on the relationship between attitudes towards science and epistemological beliefs, used this common definition. He defined attitudes towards science, as
“positive or negative opinions that individuals have about science, based on their perceptions of science—as a school subject, as an aspect of society, and as a human endeavor” (pp. 199-200).

Another way in which attitudes towards science can be defined is that of the value that is placed on aspects and issues of science. Cobern (2001) developed the TSSI to measure the way in which people think about the popular perceptions of science. He did not use the typical definitions of attitudes towards science as are used in most educational studies. His instrument is in fact, not measurement of attitudes towards science at all. Cobern (2001) said, “TSSI is not about science attitude issues” (p. 49) and was not meant to measure “attitudes towards science as usually understood in the science education community…but to) address the public place of science with respect to society and culture” (p. 7). When Fulmer (2014) used Cobern’s (2005) TSSI-v2 survey, he evaluated the results based on the “opinions” definition of attitudes, not the intended “valuation” definition that the instrument was based on.

**Epistemology and Epistemological Beliefs**

Epistemology is the study of the nature of knowledge. It includes aspects of the source, certainty, nature, and justification of knowledge (Borgerding, Deniz, & Anderson, 2017; Hofer & Pintrich, 1997; Phan, 2008; Schommer, 1990). There are a number of philosophical positions as to the source of knowledge. One of these, epistemological pluralism, posits that there are various fields of study that contribute to human knowledge. Science is one of the areas of study from which knowledge can be acquired. Science is a “powerful tool for the accurate description of Nature and illumination of natural processes” (Cobern & Loving, 2002, p. 444), and as such deserves a position of recognition with regards to knowledge acquisition. However, it is not the only way to obtain knowledge, in other words, it does not deserve privilege nor is it a law unto itself as some would suggest or argue. Epistemological pluralism is the response to
epistemological sovereignty (Healy, 2003) and the hegemony claims of scientism (Cobern & Loving, 2002). Scientism claims that science has a:

cognitive basis that is beyond question…(that) only through science can we be
assured of the accuracy of any concept…(that) it alone can establish the
soundness of our claims to knowledge, and…(that its method results in) definitive
answers to the questions that human beings pose. (Nadeau and Desautels, 1984, p. 13)

Distinct from scientism, epistemological pluralism recognizes that there are other bodies
of knowledge that people will seek that are not answerable within the purview of science. Healy
(2003) said that it (epistemological pluralism) “surmounts the constraints imposed by adherence
to narrow representational perspectives, and the methods that attach to them, by legitimating and
facilitating the deployment of other relevant perspectives and methods in parallel with them” (p. 694).

Models and theories explain the way in which beliefs of knowledge are acquired. Early,
foundational studies on this were done by Perry (1968) and provided a “platform for multiple
lines of research on epistemological beliefs” (Hofer & Pintrich, 1997). Phan (2008), through a
review of epistemological theories, said that the work of Perry was the origination of “the focus
of epistemological beliefs in learning and academic development” (p. 78). Perry’s work
involved college students and the first model in the classification of college students’
epistemological beliefs was a developmental model. Perry’s model was a unidimensional model
which explained the development of epistemological beliefs in terms of a fixed progression of
stages (Perry, 1968). Perry’s model proposed a series of nine positions of epistemological belief
development that college students progress through. It suggested that college students come into
college with dualistic views of knowledge that are expressed with simple belief in right and wrong. Their views of knowledge move to relativistic beliefs that knowledge is not certain and then to acceptance of the relativistic beliefs.

Opposed to Perry’s developmental model of epistemological beliefs are multidimensional models. Schommer (1990), in response to conflicts of results recorded with the use of Perry’s questionnaire, suggested that the inconsistencies were maybe the result of “shortcomings in the current conception of epistemological beliefs” (p. 498). Schommer proposed that epistemological beliefs were too complex to be unidimensional and were more likely “belief system(s)…composed of more or less independent dimensions” (p. 498). Schommer suggested a multidimensional model of epistemological beliefs based on four factors; innate ability, simple knowledge, quick learning, and certain knowledge. Schommer’s findings lead to five conclusions:

(1) personal epistemology can be characterized as a system of more or less independent beliefs;

(2) these beliefs have distinct effects on comprehension and learning;

(3) epistemological beliefs are influenced by home and educational background;

(4) these effects exist beyond the influence of variables found to influence comprehension and learning; and

(5) these effects are generalizable across two content domains. (Schommer, 1990, p. 503)

Schraw et al. (2002) said that “the study of epistemic beliefs is in its infancy. Researchers need better instrumentation and methodology to construct a better theoretical and applied understanding of epistemic beliefs” (p. 190). In 2002, Schraw et al. developed an Epistemic
Belief Inventory (EBI) based on Schommer’s instrument of four factors. At the conclusion of the development of the EBI, an additional factor to Schommer’s four factors; that of Omniscient Authority, was determined.

**Religion and Religiosity**

James 1:27 (ESV) says that “Religion that is pure and undefiled before God the Father is this: to visit orphans and widows in their affliction, and to keep oneself unstained from the world.” According to the Bible, religion has practical, behavioral actions that prove it. This is referred to modernly as religiosity. According to “Religiosity” (2008), religiosity is religious behavior. More specifically “the way in which religious ideas influence communities and people and in turn shape social reality” (p. 163). Locke describes the move of personalized individual inner religion to social religiosity having the purpose of edification, the public worship of God, the propagation of truth and continuation of the Gospel (Sakal, 2016).

There are a number of dominant forms of religiosity. One of these is fundamentalism. Fundamentalists follow “strict adherence to religious doctrines in their original form in order to restore previous social order in the present world” (“Religiosity,” 2008, p. 162). Groups that fall under this definition and are therefore considered to be fundamentalists, are peaceful, devout Muslims, extreme terrorists, as well as some Christian denominations (“Religiosity,” 2008).

Religion is often considered or assumed to be in conflict with science learning and thinking. Reiss (2010) said that “there is a growing acknowledgement that for some students a religious perspective can hinder the sort of science learning that most science educators would like to see” (p. 92). This is particularly highlighted and noted in the area of evolution. Borgerding et al. (2017) found that epistemological beliefs and acceptance of evolution were related across Perry’s levels of epistemological beliefs. He interpreted this relationship in two
ways; “1) that evolution rejecters may be encouraged by advisors to not continue in biology major fields or may self-select out of the major, or 2) as a result of the coursework they become more accepting of evolution” (p. 512). The results of a study done by Manwaring et al. (2015) suggested that while there was a negative relationship between religiosity and acceptance of evolution, there was a positive relationship between understanding of religious doctrine, knowledge, and acceptance of evolution. Fulmer’s (2014) evaluation of his results led him to indicate a negative relationship between religion and attitudes towards science.

However, if the history of the relationship between science and religion is reviewed, conflict between the two is not what is prevalent. Zeller (2011) said that “despite the occasional conflict, the story of the relationship between science and religion in America has not been on(e) of warfare. Rather, (it)...is one of fruitful conversation, creative dialogue, specific conflicts over particular issues, and constant change” (p. 148). Cobern’s TSSI has a category called Science and Religion (originally Science, Religion and Morality) that is meant to investigate the views of populations towards the popular notion of science and religion. This popular notion is described by Cobern and Loving (2002) to be:

People make moral choices about the use of scientific findings but science itself is morally neutral. Science is also neutral with regard to religion. The importance of science, however, is such that science must be protected from the intrusive activities of some religions. (p. 1021)

Using Cobern’s (2005) TSSI-v2, populations that are responding to questions in the category of religion are not making statements of their feelings about science as religious or non-religious but rather commenting on their views of this popular notion of science and religion. The results of a study done by Cobern and Loving (2002) using the TSSI indicated that with
respect to science and religion, although pre-service elementary educators did not esteem science more highly than religion, they were not anti-science. However, when Fulmer (2014) used Cobern’s TSSI-v2 (Cobern, 2005), Fulmer created a category called “non-religious” which was used to characterize students’ feelings towards science based on if they viewed it as religious or non-religious.

For Christian educators who teach science, whether the educational setting is Christian or secular, there is a further purpose for which science is taught as well as another factor that affects attitudes. Byrne (1961) said that “through voice, he gives expression to the truth concerning the nature of God revealed in Divine Revelation as seen in nature” (p. 127). Christian education can include but should ultimately exceed the mainstream theoretical frameworks that drive educational programs. Byrne (1961) stated that “training should be integrated and correlated with the Christian Theistic World View. Here the spiritual and theological truths of our faith will take precedence and be the means of interpretation and evaluation of all other fields of knowledge” (p. 128). On the other side of the spectrum is the secular viewpoint that perceptions and attitudes are negative if science is deemed to be religious (den Brok, Fisher, & Koul, 2006; Fulmer, 2014). This is the viewpoint that Fulmer (2014) took in his study and the reason for the creation of the “non-religious” category.

**Effects of Students’ Attitudes on Achievement and Career Choice**

Danivan (2014) at the beginning of his study said that “education is the key to community development and the success and prosperity of the nations’ depends on the quality of the academic system” (pp. 403-404). Many educational studies and literature review articles begin by noting importance of academic achievement and attitudes to success of a society (Danivan, 2014; Osborn, Simon, & Collins, 2003, the success of nations (Ahmad & Rehman,
2014; Bolshakova et al., 2011; Munck, 2007) and specifically the leadership of the United States in the area of science (Tai et al., 2006). Many also point to the importance of positive attitudes because it affects students’ career choices in science-related fields (Denessen, Vos, Hasselman, & Louws, 2015; Kapici & Akcay, 2016; Munck, 2007; Taskinen, Schutte, & Prenzel, 2013; Shamai, 1996; Tai et al., 2006).

Educational studies have long linked the attitudes that students have towards a subject to their academic achievement (Harty et al., 1985) and specifically the attitudes that students have towards science to their achievement in science (Hough & Piper, 1982; Schibeci & Riley, 1986). In these landmark studies, Hough and Piper (1982) investigated the relationship between attitudes towards science and achievements in science among intermediate elementary students \((N = 583)\) using residual gain scores to minimize the effects of individual differences. The Hough Pupil Process Test was used to test students’ science achievement and the Hough Attitude Inventory to test students’ attitudes towards science. Analysis indicated significant relationships between the residualized gain scores in science and attitudes towards science \((r = 0.45)\) by which Hough and Piper (1982) concluded that there was a significant relationship between students’ attitudes towards science and their science achievement. In 1985, Harty et al. expanded these findings to the tendencies within attitude of interest in science, and reactive curiosity in a population of fifth grade students \((N = 293)\). In their study, the relationship between fifth grade students’ achievement in science (the dependent variable) and their attitudes towards science (the independent variable) was examined using regression analysis. Although stepwise multiple regression analysis did not indicate attitudes towards science to be a predictor of achievement, Pearson-product moment correlation analysis indicated significant positive relationships between achievement in science and the attitudes towards science \((0.11, p < 0.05)\). The authors
determined these results to have implications for elementary educators in helping students develop positive attitudes towards science.

Continued research more recently conducted also shows this relationship between attitudes that students have towards a subject and their achievement in that subject (Daviran, 2014; Odem & Bell, 2013; Osborn et al., 2010; Tai et al., 2006). This relationship has been studied in many age groups. Danivan (2014) conducted his investigation with 3rd grade students, Odem and Bell (2015) investigated this relationship using 7th and 8th grade students, and Denessen et al. (2015) used 9th grade students. The studies have also been conducted in many different countries and settings; in Turkey (Danivan, 2014), Dutch primary schools (Denessen et al., 2015), and Midwestern United States (Odem & Bell, 2013).

Another effect of students’ attitudes towards science is that it impacts their future course choices and career choices (Ali et al., 2013; Denessen et al., 2015; Kapici & Akcay, 2016; Lu, Chen, Hong, & Yore, 2016; Shamai, 1996; Tai et al., 2006; Taskinen et al., 2013). In an early article by Finkel (1957) three factors were noted as reasons that students didn’t take more science in high school. These reasons were that,

(a) science was too difficult and involved too much mathematics; (b) the student’s background in science while in elementary school had been poor and uninteresting; (c) because the school offered so many important and desirable courses in competition with science that students found it difficult to make the proper choice...difficult nature was implied by the principals, guidance, and science teachers (p. 119).

However, in another later study by Shamai (1996), the attitudes that 6th grade students had towards science did not seem to affect their later choice of course study or career choices.
Later studies seem to contradict this. In their article, Denessen et al. (2015) stated that “the cause for students not choosing science and technology related studies is usually not concerned with students’ abilities but with their perceived attractiveness of science and technology related subjects” (p. 1). Different age groups have been studied; 8th grade students (Tai et al., 2006), 9th grade students (Denessen et al., 2015) and senior high students (Lu et al., 2016) in different countries; Israel (Shamai, 1996), Germany (Denessen et al., 2015), Taiwan (Lu et al., 2016) and the United States (Tai et al., 2006). These studies concluded that positive attitudes and interest were linked to increased likelihood of pursuing science-related careers in the future. Correspondingly, Ali et al. (2013) found that negative attitudes towards science kept students from choosing science-related careers. These seemingly contradictory results to Shamai’s (1996) study could be due, as Shamai (1996) noted, to 6th grade students simply being too young to make those decisions accurately.

Unfortunately, at the same time that studies reveal that positive attitudes are related to science achievement and career choices and negative attitudes are related to not choosing science as a career choice, studies also show that attitudes towards science decline over the course of students’ school years (Ali et al., 2013; Kapici & Akcay, 2016) as well as within a single year (Denessen et al. 2015). This trend is seen both among middle school students in one year (Kapici & Akcay, 2016) and from elementary through high school (Ali et al., 2013). Because attitudes towards science are related to students’ intents to choose science as a career, as this decline in attitude occurs, so does the intention to choose science as a career (Ali et al., 2013). In their long-term study, Ali et al. (2013), researched third, seventh, and 11th grade students over a 30-year period of time and noted a steady decline of enjoyment in studying science and in choosing science as a possible career path as the students progressed through these grades.
Kapici and Akcay (2016) noted the same decline among middle school students in Turkey. The authors concluded that this was due to the way in which science classes are typically run; that is a traditional classroom setting with lecture and textbook learning. The authors advised that teachers provide more hands on, student participation kinds of learning to the students to increase their attitudes towards science. This suggestion harkens back to an earlier study done by Siegel and Ranney (2003), in which the type of curriculum, “realistic, issue-oriented science activities” (p. 767) was shown to improve the attitudes of high school students towards science within a school year. The authors (Ali et al., 2013; Kapici & Akcay, 2016) also advised that teachers participate in programs to increase their science content knowledge or that schools hire teachers that are content specialists in the science area.

This trend of decline in attitudes towards science was also noted within one year in third grade students in a study done by Denessen et al., (2015). This longitudinal one-year study was done using Dutch students in elementary school (N = 1822). Student attitudes were measured at the beginning and end of the school year using a student attitude questionnaire with Cronbach’s alpha reliability at the beginning of the year; α = .74, and at the end of the year; α = .80. And the results were analyzed with t-tests and analyses of variance to measure the differences in attitudes from the beginning to the end of the year. Results showed that the students’ attitudes towards science declined from the beginning to the end of the year; F(1,1820) = 36.67, p = .001).

**The Role of Teachers on Students Attitudes and Achievement**

The impact that teachers have to the educational progress of students has been recognized for decades. Lamb (1956) said;

The teacher is the most important factor in education no matter how beautiful the school building and modern the equipment, they are at best the setting for learning, important
but not decisive elements in the educational process. It is the teacher who determines the opportunity that children will have at school. The teacher in fact manipulates the environment of children so that they may have significant learning experiences. (p. 2)

Since 1956, many more studies have been done to investigate the relationship between teachers’ attitudes and students’ achievements. Earlier landmark studies by Shine (as cited in Daviran, 2014), Flanders (as cited in Daviran, 2014), and Reed (as cited in Daviran, 2014) in found significant and positive relationships between teacher attitudes and student academic achievements (Daviran, 2014). More recent studies have been done that investigate different aspects of teachers practices to their students’ attitudes, achievements, behaviors, motivations, and choice of careers in order to make the tasks of teachers effective. Ahmad and Rehman (2014) stated that, “Teachers are the builders of a nation and their task is teaching and training the students” (p. 14). The aspects or facets of teachers’ that have been studied as to their relationship to students’ attitudes and achievements are; teachers’ attitudes (Ahmad & Rehman, 2014; Boonen et al., 2014; Daso, 2013; Daviran, 2014; Denessen et al., 2015; Eggen & Kauchak, 1988; Hoy & Davis, 2006; Lu et al., 2016; Munck, 2007; Palardy & Rumberger, 2008; van den Bergh, Denessen, Hornstra, Voeten, & Holland, 2010), character (Cottaar, 2012), self-efficacies (Bolshakova et al., 2011; Mojavezi & Tamiz, 2012), teaching styles and practices (Ahmad & Rehman, 2014; Blazar & Kraft, 2017; Boonen et al., 2014; Daso, 2013; George & Kaplan, 1998; Munck, 2007; Odem & Bell, 2015; Palardy & Rumberger, 2008; Rice et al., 2013), background qualifications (Boonen et al., 2014; Palardy & Rumberger, 2008), interpersonal behaviors (den Brok et al., 2006; den Brok, Fisher, & Scott, 2005; Lu et al., 2016; Telli, den Brok, & Cakiroglu, 2010; van den Bergh et al., 2010), combination of attitudes, background qualifications and practices (Boonen et al., 2014). These facets of teachers have all been under scrutiny to
investigate their relationship to students’ attitudes, achievements, behaviors, motivations and choice of careers. As with the research that investigated the relationship between students’ attitudes and their achievements and choice of careers, this research has been done across grade levels and settings.

Studies have been conducted using students across the gamut of school years; elementary students (Blazar & Kraft, 2017; Boonen et al., 2014; den Brok et al., 2005; Denessen et al., 2015; Palardy & Rumberger, 2008; van den Bergh et al., 2010), middle school students (Bolshakova et al., 2011; Munck, 2007; Odem & Bell, 2015) and high school students (Ahmad & Rehman, 2014; Cottar, 2012; Daso, 2013; den Brok et al., 2005; Lu et al., 2016; Mojavezi & Tamiz, 2012). Studies have been conducted across many countries and nationalities: Turkey (Onen & Ulusoy, 2012; Telli et al., 2010), Hong Kong (Sivan & Chan, 2013), Iran (Mojavezi & Tamiz, 2012), Lahore Cantonment in Pakistan (Ahmad & Rehman, 2014), Flanders (Boonen et al., 2014), Nigeria (Daso, 2013), United States (Blazar & Kraft, 2017; Munck, 2007; Odem & Bell, 2015; Palardy & Rumberger, 2008), Taiwan (Lu et al., 2016), Netherlands (Denessen et al., 2015; van den Bergh et al., 2010); Hispanic students (Bolshakova et al., 2011). Studies have also been conducted across many subjects: math (Blazar & Kraft, 2017; Boonen et al., 2014; Daso, 2013; Palardy & Rumberger, 2008), reading (Palarady & Rumberger, 2008), and science and technology (Bolshakova et al., 2011; Denessen et al., 2015; Lu et al., 2016; Munck, 2007; Rice et al., 2013).

Among 10th grade students from Pakistan, student achievement was found to be higher in classrooms where the teachers were friendly and enthusiastic (Ahmad & Rehman, 2014). This is also true of the relationship between the educational positive attitudes of teachers and students’ achievement, among 3rd grade students in Iran (Daviran, 2014). The self-efficacy of teachers
was found to be related to increased students’ achievement and motivation in high school students in Iran (Mojavezi & Tamiz, 2012) and of Hispanic middle school students (Bolshakova et al., 2011). The negative expectation attitudes of teachers against elementary aged minority students in the Netherlands was found to negatively affected those students’ achievements (van den Bergh et al., 2010). In a study with first grade students, the educational background of teachers had little relationship to students’ achievements in math (Palardy & Rumberger, 2008), although the teachers’ educational background did make a difference for the reading achievements of those same students (Palardy & Rumberger, 2008).

Recommendations made as a result of these studies called for teachers to change from a traditional to more student-friendly class atmosphere (Ahmad & Rehman, 2014), for workshops and in-service training to be held by the government and schools for teachers (Daso, 2013; van den Bergh et al., 2010), opportunities to be provided by administration that allows teachers to increase their self-efficacy (Mojavezi & Tamiz, 2012), and teacher education programs to provide more content-specific courses (Blazar & Kraft, 2017).

Specifically, in the area of science, Denessen et al. (2015) noted that, “students generally do not seem to like to study science very much. Research on student attitudes towards science and technology consistently points to an increasingly negative attitude towards science in students as they get older” (p. 1). The relationship between different facets of teachers science attitudes (Ali et al., 2013; Denessen et al., 2015; Munck, 2007), practices, background, and interpersonal behaviors (den Brok et al., 2005) and the science attitudes and achievements of their students also has been noted (Bolshakova et al., 2011; Rice et al., 2013), while at the same time, noting the shortage of teacher’s well educated in science (Bolshakova et al., 2011; Velthuis et al., 2015). Rice et al. (2013) studied the relationship between a teacher’s support for students
and their science attitudes and self-efficacy over a broad range of ages. These studies showed a positive relationship between the interpersonal relationship of secondary science teachers and students’ attitudes towards science (den Brok et al., 2005), and teacher effectiveness and science self-efficacy in middle school students (Bolshakova et al., 2011). Interestingly, in a sea of research studies that link teachers’ attitudes with the students’ attitudes with achievements, there is some contradictory research. Munck (2007), found no relationship between the science teaching attitudes of teachers and student achievement, although he concluded that this may have been due to inaccurate representation of attitudes held by the teachers, lack of skill to teach science, or not teaching the content that aligns with the benchmark tests (p. 21). Research done specifically on elementary science students indicates a relationship between students’ attitudes towards science and teachers’ attitudes. The results of a one year longitudinal study by Denessen et al. (2015) using ($N = 91$) teachers and ($N = 1822$) higher primary students, indicated that there was less of a decline in students’ attitudes towards science if the teachers’ attitudes were more positive. Similarly, research done with middle school students indicates that attitudes towards science are related to science achievement. Odom and Bell (2015) conducted a study using ($N = 602$) seventh- and eighth-grade students. The results of their study showed that attitudes towards science was related to achievement.

While some studies don’t show the same direct relationship between teachers’ attitudes and students’ achievements (Cottaar, 2012; Eggen & Kauchak, 1988), they still indicated the same relationship, but indirectly. In Eggen and Kaughak (1988) this indirect relationship was explained that in order for teachers to teach effectively, their attitudes, beliefs, and perceptions must be positive and then that this more effective teaching resulted in higher achievement of students. This is also true of the relationship between teachers’ pleasant attitudes and being
centered on the achievement of students (Cottaar, 2012). While the results of their study did not show a significant direct effect between teacher characteristics and achievement, at most 3% of the achievement variation, it did show a significant effect on students’ interest and learning activities. The authors concluded that this indirect effect on interest and learning could be as important or more important on general education than a direct effect on achievement.

A call for improvement of screening of teacher applicants beyond certification (Palardy & Rumberger, 2008), in-service programs for teachers focusing on improved science instruction by the teacher (Palardy & Rumberger, 2008), assessments to allow teachers to be aware of their attitudes (van den Bergh et al., 2010), and proper support for teachers has been called for as a result of these studies. Additionally, recommendations for teacher education programs were given.

Educators’ Attitudes Towards Science

This then leads to educational studies of the attitudes that are typical for teachers towards science (Bleicher, 2007; Denessen et al., 2015; Kenny, 2010; McDonnough & Matkins, 2010; Young, 1998). The importance of these studies was summarized by Young (1998):

> Attitudes form and change throughout a person’s life. If changes are to be made in the uptake of science at all levels, then positive attitudes must be formed during a student’s primary and secondary school career. This, in turn, relies on teachers themselves having a positive attitude towards this area of the curriculum. (p. 107)

Many studies have been done because of the concern that elementary educators hold negative attitudes towards science (Baldwin, 2014; Buaraphan, 2011). Typical classroom teaching of science by an educator via a textbook as the main tool of learning “eliminates student motivation and logically seems to be responsible for the increasing negative attitudes toward science that
remains and increases as student[s] advance across grade levels” (Ali et al., 2013, p. 116). In a study done by George and Kaplan (1998), it was found that “science activities…[have] the strongest direct effect on science attitudes…. [and that] students need to take an active role in the learning of science” (p. 105). Specific professional development efforts and interventions that focus on instructing a science teacher in ways to make science more hands-on and exciting have been found to increase the positive attitudes of teachers toward teaching science as well (Pendergast et al., 2017).

In the study conducted by Pendergast et al. (2017) with prekindergarten teachers (\(N = 112\)), results suggested that prekindergarten teachers that participated in professional development activities that were science-related were significantly more likely to enjoy conducting science activities with their students (\(t(102) = -2.053, p = .043\)) and to feel more comfortable planning and demonstrating life science activities (\(t(108) = -2.152, p = .034\)) and physical and energy science activities (\(t(107) = -2.007, p = .047\)). In a quasi-experimental pretest-posttest control group design Aalderen-Smeets and Walma van der Molden (2015) investigated the effects of a professional development training course for elementary teachers (\(N = 61\)) that was based on inquiry science. Their study was based on the theoretical framework Attitude towards (Teaching) Science developed by Aalderen-Smeets, Walma van der Molden, and Asma (2012). Results shows a large positive affect on the attitudes of primary school teacher toward teaching science (\(\Lambda = .82, F(6, 99) = 3.65, p = .003, \hat{\eta} = .18\)). Similarly, in a pre-/post-intervention research design, Smith (2015) used primary teachers (\(N = 24\)) and students (\(N = 281\)) to investigate the effects professional development programs that focused on inquiry-based instruction had. Results showed that teachers’ lessons became more inquiry-based and students’ attitudes toward science became more positive.
In a mixed methods approach that studied the impact of Research Experiences for Teachers (RETs) as a type of professional development, Enderle et al. (2014) conducted an experiment with educators \((N = 106)\) from elementary through high school from a range of disciplines and experiences. Analysis from their study found that teachers’ beliefs and attitudes improved with the RETs, but that for elementary educators it did not change their classroom practice. A study done by Ambusaidi and Al-Farei (2017), indicated that years of experience affected teachers’ attitudes. Their study indicated that teachers with more than five years of teaching experience had more positive attitudes towards teaching than those with fewer than five years teaching experience. Results indicated that there was a significant difference in classroom preparation and management in favor of teachers who had six or more years of experience.

**Preservice Elementary Educators Attitudes Towards Science**

Studies that have been done to determine the attitudes that preservice elementary educators have towards science or teaching science are mixed in their results. Some studies done have indicated that pre-service elementary educators typically have negative attitudes towards teaching science (Bleicher, 2007; Kenny, 2010; McDonough & Matkins, 2010; Young, 1998). Others show that although science teachers, or those that have science as a specialist subject, have more positive attitudes towards science than those that don’t have science as their specialty, those without science specialties also have positive attitudes (Ugras, Altunbas, Ay, & Cil, 2012; Young, 1998). Other studies done just with pre-service teachers or teacher candidates show that they have positive attitudes towards science (Buaraphan, 2011; Cobern, 2005; Tasdemir & Kartal, 2013; Ugras et al., 2012), but that this can become more negative as they experience science educator courses (Buaraphan, 2011).

**Factors That Affect Pre-Service Elementary Educators Attitudes Towards Science**
Important among these differing results of science attitudes among educators are the results of studies on the factors that affect pre-service elementary educators’ attitudes towards science. These have been deemed important because of the concern for science teaching in elementary schools (Avery & Meyer, 2012). In the same way that research has indicated that there are relationships between various factors and school children’s attitudes towards science, so research has also indicated a relationship between various factors and the population of pre-service elementary educators’ attitudes towards science and teaching science (Bayraktar, 2011; Denessen et al., 2015; Kazempour, 2014; Kirik, 2013; Senler, 2016).

Factors studied have included self-efficacy (Avery & Meyer, 2012; Denessen et al., 2015; Kazempour, 2014; Kirik, 2013; Metin, Acisli, & Kolomuc, 2012; Mohamadi & Asadzadeh, 2012), collaboration (Ambusaidi & Al-Farei, 2017; Hanuscin & Zangori, 2016; Velthuis et al., 2015), perceived relevance of science to their daily lives (Senler, 2016; Urey & Cerrah Ozsevgec, 2016; van Aalderen-Smeets, Walma van der Molen, & Asma, 2012), background (Metin et al., 2012), gender (Buaraphan, 2011; Ilhan, Ylimaz, & Dede, 2015; Metin et al., 2012), and grade level (Metin et al., 2012), and previous science experience, initial interest in science, course experience (Kazempour, 2014).

**Perceived competence (self-efficacy).** As a result of their study, Denessen et al. (2015) concluded that “teachers’ enjoyment in teaching about science and technology was linked to their perceived competences” (p. 4). One of the manifestations of Bandura’s (1997) construct of self-efficacy within his social cognitive theory is the perceived competence that a person has towards a task. Because the social cognitive theory links self-efficacy to behavior (attitudes) and perceived competence is a manifestation of self-efficacy, perceived competence will affect attitude. Studies done on factors that affect the self-efficacy of pre-service elementary educators
have found that personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) could be predicted by positive attitudes towards teaching science (Kirik, 2013), while Mohamadi and Asadzadeh (2012) found teachers’ self-efficacy to have a mediating role between sources of self-efficacy and students’ achievements. A qualitative study done by Kazempour (2014), indicated that self-efficacy, attitudes and beliefs are all necessary constructs to consider in monitoring the ability to teach science or to have a sound teaching practice relative to teaching science. Factors that have been found to have a relationship to science self-efficacy and attitudes towards science of pre-service elementary educators are research (Ilhan et al., 2015), teacher-training course with a focus on inquire-based learning approach (van Aalderen-Smeets & van der Molen, 2015), and anxiety (Senler, 2016). Ilhan et al. (2015) performed a study on preservice science educators (N = 517) in five schools in Turkey. The results of their study indicated a significant positive relationship between the attitudes of pre-service teachers towards educational research and self-efficacy towards teaching science (r = 0.417, p < .01).

Senler (2016) investigated the relationship between science teaching anxiety and science teaching self-efficacy/attitude toward teaching science. The results of the study indicated a high negative correlation between science teaching self-efficacy and science teaching anxiety (r = −0.77).

**Gender.** The relationship between gender and attitudes towards science has been recognized for decades. Gardner (1975) said that “sex is probably the most significant variable related towards pupils’ attitudes to science” (p. 22). In a review of literature done by Osborne et al. (2003), numerous sources from studies done in the 1980’s and 1990’s were cited that pointed to the attitudes of girls towards science being less positive than that of boys towards science (Osborne et al., 2003). More recently conducted studies have also indicated that female students
have less positive attitudes than males (Breakwell & Robertson, 2001; Fulmer, 2014). Research conducted specifically using populations of preservice elementary educators’ and their attitudes towards science that includes or focuses on gender as a factor is, however, not conclusive. Most studies done have indicated that male teachers have more positive attitudes towards teaching science (Denessen et al., 2015; Riegle-Crumb et al., 2015). Buaraphan (2011) conducted a study that specifically used pre-service science teachers. His study found that male participants had significantly more positive attitudes towards science than females. While Denessen et al.’s (2015) research into the relationship between perceived competence and enjoyment in teaching, indicated that females had less enjoyment in teaching science than males, and at the same time also reported lower levels of perceived competence.

While the majority of studies done seem to indicate that male students in general have a more positive attitude towards science than females, not all the research points that way. In a study done with randomly selected science teachers ($N = 139$) that taught 5th through 10th grade students in Oman, Arabia, results indicated that female teachers had more positive attitudes towards teaching than male teachers (Ambusaidi & Al-Farei, 2017). This was also true of pre-service science teachers’ attitudes towards research (Ilhan et al., 2015).

As the third possibility, results of a study done by Metin et al. (2012) indicated that there was no difference between pre-service elementary educators’ attitudes towards science and gender. Also, no difference was noted between male and female pre-service elementary educators with regard to the relationship between efficacy beliefs and attitudes towards science (Bayraktar, 2011) and minor difference between genders and their success in the science field (Osborn et al., 2003).
**Collaboration.** For elementary educators, being able to collaborate with and learn from other teachers increases their positive attitudes towards teaching science (Velthuis et al., 2015). The results of the qualitative research design study by Velthuis et al. (2015) found that primary school teachers (N = 5) that participated in Teacher Design Teams (TDTs) increased their science teaching self-efficacy. Results indicated that participating in teams helped to increase the personal science teaching efficacy (PSTE) and/or science teaching outcome expectancy (STOE) of teachers that were in different places in their teaching career (pre-service, 3 years, experienced) and also those with different levels of interest in science. This was supported by the research done by Ambusaidi and Al-Farei (2017) in which teachers indicated that more interaction with fellow science teachers was helpful in improving self-efficacy. In an interpretive approach to a qualitative design study, Hanuscin and Zangori (2016) used elementary education majors (N = 18) to examine the impact that a CoLABorative Field Experience (CFE) had on Next Generation Science Standards (NGSSs). The results indicated the positive aspect of collaborative opportunities for repeating the same lessons is important in the context of field experience and viewing science from students’ points of view.

**Perceived relevance to daily life.** If a teacher deems the profession to be important and significant he will have a more positive attitude towards it (Cristina-Corina & Valenica, 2012). In a study of Romanian teachers (N = 201) to examine the relationships between teachers’ attitudes and their perceptions of teaching, Cristina-Corina and Valenica (2012) found a positive correlation between many aspects of teachers’ perception of their work and their attitudes; perception of their motivating potential and attitude (p > 0.05, F = 3.02, p = 0.000), perception of responsibility and social importance and attitude (p > 0.05, F = 2.97, p = 0.000). In a study of Romanian teachers in elementary, middle and high schools (N = 201), results indicated that the
attitudes were affected by many aspects of their perceptions towards their profession (Cristina-Corina & Valenica, 2012). Likewise, one of the factors that research indicates is necessary to the positive attitudes of preservice elementary educators towards science is their perception of its relation or importance to their daily lives (van Alderen-Smeets et al., 2011; Ilhan et al., 2015; Urey & Cerrah Ozsevgec, 2016). In the development of their attitudes towards science instrument, van Alderen-Smeets et al. (2011) noted that content knowledge in and of itself was not enough to increase the positive attitude of primary teachers, but that they had to have a sense of its importance and relevance. In a study done by Urey and Cerrah Ozsevgec (2016), with second year preservice elementary educators ($N = 200$), results indicated a significant relationship between scientific literacy and attitudes towards science ($r = 0.58; p = 0.000, p < 0.01$), and a weakly positive relationship between their scientific literacy and application to their daily lives. ($r = 0.32; p = 0.001, p < 0.01$). Because pre-service elementary teachers perceive their science courses as not being applicable to their daily lives, they tend to memorize instead of understanding concepts and this leads to the low scientific literacy and attitudes. Research is an area that provides hands on opportunities for students. It can also help to link concepts to real life (Ilhan et al., 2015).

**Teacher education programs.** Although in some content areas, the relevance of student teacher training has been called into question (Blouin & Moss, 2015), Buaraphan (2011), when describing the effect of teacher education programs on science teacher, said, “Attitudes in general must have an anchor. Attitudes toward science teaching, as an example, use ‘science teaching’ as the anchor” (p. 62). He went on to say that teacher education programs have the opportunity and responsibility to establish a positive anchor toward science teaching attitudes. This has been noted by authors of other studies (Avery & Meyer, 2012; Buaraphan, 2011).
Preservice science educators typically have positive attitudes towards science. In a study done with pre-service science teachers \( (N = 113) \), results showed that while their overall attitudes were positive toward science, they showed increased negative attitudes towards their ability to adequately teach science (Buaraphan, 2011). Research shows that the self-efficacy and attitudes of prospective science teachers are not significantly increased during their education programs. In fact, some studies indicated that there is an increase of negative attitude over the first semester of a standard-based science teacher preparation program (Buaraphan, 2011). If even science educators’ attitudes get more negative during education programs, it is not surprising that pre-service elementary educators typically have negative attitudes towards science and teaching science. Even if pre-service elementary educators do not come out of the programs with negative attitudes or an increase in negative attitudes, research indicates that self-efficacy is still not improving significantly (Bayraktar, 2011).

To test the self-efficacy change over the course of a four-year education program, Bayraktar (2011) tested freshmen and senior preservice elementary educators \( (N = 282) \) in Turkey. Results indicated that while there was a positive effect on science teaching efficacy beliefs \( (t = 4.791, p = .000) \) and positive attitudes of senior pre-service teachers’ were more positive than freshmen \( (t = 5.495, p = .000) \), the effect was still not considered to be sufficient.

In order to improve this trend, the teacher educator program in a large Midwestern university was changed to include a hands-on, inquiry-based course specifically designed for elementary educators. Bergman and Morphew (2015) investigated the effect of the course on pre-service elementary educators \( (N = 154) \) on self-efficacy. The results indicated that there was a statistically significant increase in science teacher outcome expectancy (STOE) scores \( t(153) = \)
4.09, \( p < .001, \alpha = .05; \) and in Personal science teaching efficacy beliefs (PSTEB) scores \( t = (152) = 5.32, p < .001. \)

This was supported in a study done by Baldwin (2014). He found that the PSTE (both self-efficacy and attitudes) of pre-service elementary educators (\( N = 50 \)) increased significantly over the course of a semester in a lab-based geology class specifically designed for elementary education majors. The type of science courses involved in an educator program has been shown to affect self-efficacy and attitudes toward science. In an early review of literature done by Morrisey (1981) research indicated that enrollment in activity-based, hands-on, field-oriented methods courses resulted in increased positive attitudes towards science. This was similarly noted in a mixed method study of preservice elementary educators enrolled in a small private Catholic institution (\( N = 26 \)) by Knaggs and Sondergeld (2015), in which it was found that pre-service teachers, who experienced the role of a learner by actually performing hands on experiments as part of their science education program, indicated that they had gained pedagogical knowledge and felt better equipped to teach science. PE significantly increased; \( t(25) = 5.00, p < .001 \) and OE significantly increased; \( t(25) = 2.27, p < .05. \)

Another addition to teacher education programs that can increase positive attitudes towards science is the implementation of informal science education (ISE) experiences. ISE experiences allow participants to visit science institutions and science and nature programs as part of their teacher education programs. Institutions that contribute to the flexibility of ISE experiences are called informal science education institutions (ISEIs). ISEI’s are places such as museums, nature centers, and other field trip destinations that provide a learning environment that is unique and that support programming of outside interest groups such as teacher education programs (Kisiel, 2013).
ISEI’s were the focus of a study by Kisiel (2013), where he investigated pre-service elementary educators ($N = 168$) enrolled in an ICE program. The students that participated in the study indicated that their science knowledge increased, they were motivated and saw value for students. Each of these things potentially resulting in an increase in science teaching self-efficacy and attitude. In a qualitative research design case study, Katz et al. (2013) studied ($N = 2$) first-year elementary educators that had been involved in (ISE) in their teacher education programs. The participants indicated that the ISE had contributed to resilience, excitement, and engagement towards teaching science.

Riegle-Crumb et al. (2015) investigated the effect that taking an inquiry-based science content course had on the attitude of pre-service elementary teachers. They found that students who took an inquiry-based science course “reported more confidence…more enjoyment and less anxiety toward science and perceived it as more relevant” (Riegle-Crumb et al., 2015, p. 832). But despite the good ideas that all these studies bring forth, there is a question as to what realistically can be expected to be achieved in a one-semester long course (Hanuscin & Zangori, 2016).

Some studies, although not all, reveal that self-efficacy beliefs are more negative as the result of the courses that are taken during education programs. In order to determine factors that could cause this Kirik (2013) investigated elementary education majors ($N = 262$) and found that they had a low science concept understanding, and that attitudes were a predictor of PSTE and STOE. Similarly, in a mixed-methods design of pre-service elementary educators ($N = 62$), Menon and Sadler (2016) investigated the relationship between science content knowledge and self-efficacy. Results shows gains in PSTE scores with conceptual understanding ($r = .35$, $p < .05$), but no significant correlation between STOE scores with conceptual understanding.
Cobern and Loving (2002) explained that the limited success of activity and inquiry oriented college science courses and science courses designed specifically for elementary educators are due to three “problematic assumptions” (p. 3) that they rest on: 1) if elementary educators need more science they will take more science, 2) if elementary educators take more science this will increase their interest, approval and enthusiasm for teaching science, and 3) science is itself non-problematic so that elementary educators will interpret it in the same way as it is communicated to them (pp. 3-5).

**Epistemological beliefs.** Epistemological beliefs are beliefs about the nature and source of knowledge (Hofer & Pintrich, 1997; Schommer, 1990). Buaraphan (2011) says that:

> Based upon constructivist epistemology, individuals are not blank slates; they come into teacher education with something constructed from their past experience such as perspectives, knowledge, beliefs and attitudes. Whatever pre-service science teachers bring with them potentially influences their interpretation and construction of meanings for becoming science teachers. Nevertheless, many science teacher educators consider pre-service science teachers as blank slates and consequently ignore to articulate their existing status. (pp. 61-62)

Many aspects of epistemological beliefs and how they affect learning and teaching have been conducted. Results of early research conducted by Schommer (1990) indicated that epistemological beliefs that students have affects their comprehension. Epistemological beliefs have been shown to influence students’ approaches to learning as well as to be predictive of academic performance (Phan, 2008). Epistemological beliefs have been found to affect different disciplines. In a study by Liu and Tsai (2008), two main academic groups were studied; those of science and non-science majors. Using a multidimensional instrument, results indicated that
science majors had less sophisticated views of knowledge than other majors (non-science and science education). Results also indicated significant differences in Science Epistemological View (SEV) dimensions across the disciplines. In a study done with preservice elementary science teachers by Yilmaz-Tuzun and Topcu (2008) it was determined that dimensions of epistemological beliefs affected the way in which the preservice elementary science teachers believed that science should be taught. In a study by Ozturk and Yilmaz-Tuzun (2017), correlations were found between pre-service science teachers’ epistemological beliefs and their reasoning about socioscientific issues.

Research also indicates that epistemological beliefs are related to attitudes towards science (Fulmer, 2014; Kilinc & Seymen, 2014), with regard to omniscient authority and innate learning (Kilinc & Seyman, 2014), and with regard to epistemological beliefs about certainty and authority (Fulmer, 2014). The purpose of Fulmer’s (2014) study was to “bridge the gap between the literature on epistemological beliefs and students’ attitudes toward science … [to] contribute to the broader effort to understand factors that can support or hinder students’ attitudes toward science” (p. 199). Fulmer used Schraw et al.’s (2002) Epistemological Belief Inventory (EBI) questionnaire and Cobern’s (2005) Thinking About Science Survey Instrument-v2 (TSSI-v2). The results of Fulmer’s (2014) study found that there is a “statistically significant, positive effect for the belief that knowledge derives from authority… [and] a significantly negative effect of believing that scientific knowledge is certain” (p. 203). Fulmer (2014) also found that “students’ perceptions of science are significantly related to their attitudes toward science” (p. 203).

Fulmer (2014) found that if students perceive science as inclusive of women and minorities that there is a significant positive effect in their attitudes and that “students have a higher attitude toward science when they perceive it as being non-religious or even as standing in opposition to
religious belief” (p. 203). This is different from a series of studies done by Cobern (Cobern & Loving, 2002; Cobern et al., 2013). Cobern and Loving (2002) did a study using pre-service elementary educators in which they concluded that the pre-service elementary educations “do not place science at the top of some epistemological pyramid nor do they consider science more important than religion” (p. 1026). And then in a study linking religion and science attitude, Cobern et al. (2013) asked two questions about the relationship between science sentiment and views of religion. They were, “Is anti-science sentiment (measured as valuation of science) associated with supportive views of religion” (p. 493) and “Is anti-science sentiment (measured as valuation of science) associated specifically with orthodox Christian belief” (p. 496). In this study to establish the relationship between the two, Cobern et al. (2013) used the TSSI-v2 and the Christian Fundamentalist Belief Scale (CFBS). This study done with 545 pre-service elementary education students from a Midwestern university where the majority of the students came from areas of the United States that had high percentages of orthodox Christians. The results of this study “did not show that anti-science sentiment increases with increasing Christian belief. Subjects with strong Christian beliefs were found to be just as supportive of science, if not more so, than subjects with no Christian beliefs” (Coburn et al., 2013, p. 488). This being the case, there is a need to examine the relationship between epistemological beliefs of elementary education majors using the EBI using the TSSI-v2 while clearly identifying students’ orthodox Christian beliefs.

**Summary**

Bandura (1977b) established with the social cognitive theory that behavior is dependent on attitude. Students’ behaviors, achievements, (Danivan, 2014; Harty et al., 1985; Hough & Piper, 1982; Schibeci & Riley, 1986) and career choices (Denessen et al., 2015; Taskinen et al.,
2013) are dependent on their attitudes. In turn, students’ attitudes are affected by their teachers’ attitudes (Ahmad & Rehman, 2014; Bolshakova et al., 2011; Boonen et al., 2014; den Brok et al., 2005; Denessen, et al., 2015). There are many factors that have been researched as to their effect on teachers’ attitudes towards science and teaching science (Cristina-Corina & Valenica, 2012; Kazempour, 2014; Urey & Cerrah Ozsevgec, 2016). Not as thoroughly investigated is the relationship of epistemological beliefs to attitudes of pre-service elementary educators towards science. Fulmer (2014) conducted a study between epistemological beliefs and attitudes towards a science using undergraduates from a large, public university in the eastern United States with the purpose of bridging a gap in the literature a study. Fulmer (2014) found that “undergraduates in general have a higher attitude toward science when they perceive it as being non-religious or even as standing in opposition to religious belief” (p. 203). However, the study had a number of discrepancies that lead to the advisability of the study being replicated. To this end, this study will replicate Fulmer’s study with a different population, taking out the non-religious category that was not in Cobern’s instrument, and the religiosity of the participants determined with a validated instrument.
CHAPTER THREE: METHODS

Overview

Research indicates that epistemological beliefs are related to attitudes toward science (Fulmer, 2014; Hofer & Pintrich, 1997; Schommer, 1990). The purpose of this study is to investigate the relationship between the epistemological beliefs of undergraduate elementary education majors in a large, private, faith-based university in southeastern United States and their attitudes towards science. Chapter Three begins with the Design section which discusses the rationale for using a non-experimental bivariate correlation design to study the relationship between epistemological beliefs and attitudes towards science. The Research Question section states the research question and the hypotheses that drive the experiment. The Participants and Settings section describes the undergraduate elementary education major population and the large, private, faith-based university in the southeastern United States setting. The Instrument section discusses the use of Schraw et al.’s (2002) Epistemological Beliefs Inventory (EBI) to measure epistemological beliefs and its development and validation. It also discusses the use of Cobern’s (2005) Thinking About Science Survey Instrument-ν2 (TSSI-ν2) to measure attitudes towards science and its development and validation. The Data Analysis section discusses how the results of the study are analyzed using Pearson’s product-moment correlation coefficient ($r$). It includes descriptions of the assumptions and testing involved with the use of Pearson’s $r$.

Design

The purpose of this study was to investigate the relationship between the epistemological beliefs of undergraduate elementary education majors at a large, private, faith-based university in southeastern United States and their attitudes towards science. Because the function of the correlation design was to discover relationships between variables (Gall, Gall, & Borg, 2007, p.
a quantitative correlation design was used in this study. Further, there are a number of
dimensions within each variable that may be found to affect each other. A correlation design also
allowed for analyzing the relationships among many variables to see how these variables
affected the relationship (Gall et al., 2007, p. 336). In this study, the criterion variable is
attitudes towards science, and the predictor variable is epistemological beliefs. (Creswell, 2012;
Gall et al., 2007). Epistemological beliefs were measured using Schraw et al.’s (2002)
Epistemological Beliefs Inventory (EBI). Attitudes towards science were measured using

The predictor variable is epistemological beliefs. Epistemological beliefs are defined by
Schommer (1990) as “a belief system that is composed of several more or less independent
dimensions” (p. 498). Schommer (1990) identified five dimensions of epistemological beliefs,
described and defined as the following;

(a) “Knowledge is simple rather than complex” (Simple Knowledge), (b) “Knowledge is
handed down by authority rather than derived from reason (Omniscient Authority), (c)
“Knowledge is certain rather than tentative” (Certain Knowledge), (d) “The ability to
learn is innate rather than acquired” (Innate Ability or Fixed Knowledge), and (e)
“Learning is quick or not at all” (Quick Learning). (p. 499)

The criterion variable is attitudes toward science. Within this study, attitudes towards
science are defined as the attitudes held towards the “commonly held worldview of science
portrayed in the medial and in popular science and science education literature” (Cobern &
Loving, 2002, p. 1016), or to “illuminate the balance and valuations people hold about science in
the context of several other culturally and socially – but not scientific per se – important issues”
(Cobern, 2001, p. 49).
**Research Question**

**RQ1:** Is there a relationship between the epistemological beliefs of undergraduate elementary education majors and their attitudes towards science?

**Hypotheses**

**H₀₁:** There is no statistically significant correlation between epistemological beliefs about omniscient authority of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**H₀₂:** There is no statistically significant correlation between epistemological beliefs about certain knowledge of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey-v2.

**H₀₃:** There is no statistically significant correlation between epistemological beliefs about quick learning of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**H₀₄:** There is no statistically significant correlation between epistemological beliefs about simple knowledge of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**H₀₅:** There is no statistically significant correlation between epistemological beliefs about innate (fixed) ability of undergraduate elementary education majors as measured by...

**Participants and Setting**

The population used for this study were students from a large, private, faith-based university in the southeastern United States that were enrolled in the Elementary Education Integrated Studies residential program or the Special Education Integrated Studies program. The participants were selected by a convenience sample from this population. The university is accredited by the Southern Association of Colleges and Schools (SACS) and the elementary education program is approved through the National Council for Accreditation of Teacher Education (NCATE). The students in this program specialize in one of five subject cognates; English, Mathematics, Science, Social Science, and Spanish. The teacher candidate can choose to add a middle school endorsement (grades 6-8) with an additional course and applicable practicum and testing requirements. The professional education requirements for the Elementary Education Integrated Studies are: EDUC 125 Introduction to Education; EDUC 220 Differentiated Teaching & Learning; EDUC 225 Instructional Design: Elementary; EDUC 240 Introduction to Application, Education, Technology Practicum; EDUC 318 Teaching Elementary Reading; EDUC 319 Teaching Elementary Language Arts; EDUC 323 Teaching Elementary Mathematics; EDUC 324 Teaching Elementary Science; EDUC 360 Foundations of Education; EDUC 410 Elementary School Curriculum, EDUC 415 Diagnostic Measurement & Evaluation; EDUC 475 Seminar in Classroom Management. The field experiences required classes are: EDUC 226 Instructional Design Practicum: Elementary; EDUC 317 Elementary Reading and Language Arts Practicum; EDUC 411 Elementary School Curriculum Practicum; EDUC 416 Content Teaching Methods Practicum; EDUC 476/477 Student Teaching; for a total of 300
For those students enrolled in the Special Education Integrated program, the professional education requirements are: EDSP 323 Special Education Law & Characteristics, EDSP 363 Behavior Management, EDSP 413 Inclusion & Diversity: Effective Practice and Strategies, EDSP 473 Transition Planning, EDUC 125 Introduction to Education, EDUC 220 Differentiated Teaching & Learning (Elementary), EDUC 225 Instruction Design: Elementary, EDUC 318 Teaching Elementary Reading, EDUC 319 Teaching Elementary Language Arts, EDUC 323 Teaching Elementary Mathematics, EDUC 360 Foundations of Education, EDUC 410 Diagnostic Measurement & Evaluation, EDUC 415; EDUC 457 Diagnostic Measurement and Evaluation. The field experiences requirements are: EDSP 324 Special Education Law and Characteristics Licensure Practicum, EDSP 364 Behavior Management in Special Education Licensure Practicum, EDSP 414 Inclusion and Diversity: Effective Practices and Strategies Licensure Practicum, EDSP 474 Transition Planning Licensure Practicum, EDUC 226 Instructional Design Practicum, EDUC 317 Elementary Reading and Language Arts Practicum, EDUC 411 Elementary School Curriculum Practicum, EDUC 416 Diagnostic Measurement & Evaluation Practicum, EDUC 475 Seminar in Classroom Management, and EDUC 476/477 Student Teaching I & II. Student organizations to which the students can belong are; Association for Supervision and Curriculum Development Student Chapter (ASCD), Council for Exceptional Children (CEC), Kappa Delta Pi (KDP), Piedmont Area Reading Council (PARC), Professional Association of Christian Educators (PACE).

The minimum number of participants required in a correlation study for a medium effect size with a statistical power of .7 at the .05 alpha level is $N = 66$; (Gall et al., 2007, p. 145). This study met that statistical power with $N = 69$ participants. Of the respondents to the survey ($N =$
were freshman through senior students. Of these, 14 (20.3%) were freshmen, 14 (20.3%) were sophomores, 22 (31.9%) were juniors, and 19 (27.5%) were seniors. Demographics collected on years of age showed that 12 (17.4%) of the participants were 18 years of age, 14 (20.3%) were 19 years of age, 22 (31.9%) were 20 years of age, 12 (17.4%) were 21 years of age, 7 (10.1%) were 22 years of age, and two (2.9%) were 23 years of age. The ethnicity of the students was four (5.8%) were Hispanic/Hispanic American, three (4.3%) were Asian/Asian American, 60 (87.0%) were white American, zero (0.0%) registered as African/African American and two participants (2.9%) registered as “other”. Demographics collected on religious affiliation showed that 68 (98.6%) of the participants were of Christian affiliation and one participant (1.6%) registered as being of a religious affiliation other than Muslim, Jewish, or non-religious.

Table 1

Descriptive Analysis for Gender, School Level, Age, National Ethnicity and Religious Affiliation of Participant Characteristics.

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Thinking about Science Survey Instrument

Attitudes towards science was measured using version 2 of the Thinking about Science Survey Instrument (Cobern, 2005). The Thinking about Science Survey Instrument-v2 (TSSI-v2) was designed “both for pedagogical purposes with pre-service elementary teachers and for research to elucidate anti-science sentiment within this group” (Cobern & Loving, 2002, p. 1017). It was built on three assumptions: (1) that elementary teachers who need more science will make use of opportunities to learn more science, (2) that once elementary teachers have learned more science, their interest, approval, enthusiasm and effectiveness in teaching science will increase, and (3) that the communication of science is unproblematic to the science teacher, the communicator (Cobern, 2005).
The original 60-item questionnaire was culled from a pool of possible item statements based on objections and defenses for science. From the original pool of statements, 60 items were identified from responses of 40 scientists and science educators. These items were given to three to six pre-service elementary educators to describe the meaning of the statements to make sure that the questions were being interpreted as intended (Cobern, 2005).

The 60 statements were grouped into nine categories with from four to ten items (questions) per category. The nine categories; epistemology (EPIST), science and the economy (ECON), science and the environment (ENVIR), public policy and science (POLY), science and public health (HEAL), science, religion and morality (RELIG), science emotions and aesthetics (BEAUT), science, race and gender (RACE), and science for all (For_All) (Cobern, 2005). The intent of the categories was not meant to represent an authoritative scientific worldview, but a scientific worldview expressed by “popular media and the popular literatures of science and science education (Cobern & Loving, 2002, p. 1020). The descriptions of the categories are:

Category 1: Epistemology (EPIST) – Science is a superior, exemplary form of knowledge that produces highly reliable and objective knowledge about the real world.

Category 2: Science and the Economy (ECON) – Modern industrial, commercial, and information-based economies depend on scientific developments for increasing production, wealth, and general public welfare.

Category 3: Science and the Environment (ENVIR) – Science is necessary for the discovery, development, conservation, and protection of natural resources and the environment in general.

Category 4: Public Policy and Science (POLY) – Science acts in the public interest. Science should thus be supported by public funds; however, the science community is
more capable of policing scientific activity.

Category 5: Science and Public Health (HEAL) – The conquering of disease and physical affliction and the great advances in public health are made possible by science and will not continue without science.

Category 6: Science, Religion, and Morality (RELIG) – People make moral choices about the use of scientific findings but science itself is morally neutral. Science is also neutral with regard to religion. The importance of science, however, is such that science must be protected from the intrusive activities of some religions.

Category 7: Science, Emotions, and Aesthetics (BEAUT) – Scientists are often passionate about their work but the work of science best proceeds on the basis of objective reason and empiricism. There is a beauty to science. Indeed, elegance is often required of scientific ideas.

Category 8: Science, Race, and Gender (RACE) – Science is an equal opportunity employer. Race, gender, and other personal factors are irrelevant in science. This is the ubiquitous claim of the science community.

Category 9: Science for All (For_All) – The importance of science is such that it should be taught at all levels of schooling. Every citizen should have attained at least a minimal level of science literacy. (Cobern & Loving, 2002, pp. 1020-1021)

From 1997 until the Fall of 2000, the survey was given to pre-service elementary educators ($N = 398$) in their third and fourth years at Western Michigan University. The alpha reliability coefficient was calculated at 0.779; the category item alpha coefficient was calculated at 0.793 (Cobern, 2005).

The 60 items were later subjected to an interitem correlation analysis as grouped by
categories. Using positive interitem correlations and similar items means, 26 questions were identified as being redundant and were eliminated. The instrument ended up with 35 items. The instrument had an overall alpha reliability coefficient at .819. By sub-scales: EPIST: $\alpha = .748$, ECON: $\alpha = .753$, ENVIR: $\alpha = .477$, POLY: $\alpha = .776$, HEAL: $\alpha = .565$, RELIG: $\alpha = .546$, BEAUT: $\alpha = .413$, RACE: $\alpha = .769$, For All: $\alpha = .803$. Ideal alpha values of $\geq .60$ were exceeded by five of the categories. The other four categories are considered by the authors to be ideal due to the similar means of the items within the categories and the relevancy of the items’ concepts to the category.

Continued and further development and validation of the TSSI through 2008 further modified the instrument to 42 questions within the same nine categories with the following updated alpha values: EPIST: $\alpha = .748$, ECON: $\alpha = .753$, ENVIR: $\alpha = .704$, POLY: $\alpha = .776$, HEAL: $\alpha = .565$, RELIG: $\alpha = .752$, BEAUT: $\alpha = .521$, RACE: $\alpha = .769$, For All: $\alpha = .803$. TSSI uses a Likert-type response scale ranging from one (strongly disagree) to five (strongly agree) for measurement. Scores of 1.00 to 2.50 indicates a disagreement with the science Model as portrayed by the medial and popular science literature, 2.51-3.50 indicate neutral inclination towards the Model, and 3.51-5.00 indicate agreement with the Model (Cobern, 2005). The composite score was used for this study. A mean score of 5.00 in all nine categories indicates scientific thinking. A mean score of 1.00 in all nine categories indicates anti-science thinking (Cobern & Loving, 2002).

The approximate time to complete the instrument is 20 minutes. A request to use Cobern’s Thinking About Science Survey-v2 was sent to the author via email. Permission was granted by return email. See Appendix A for the email permission.

**Epistemological Beliefs Inventory**
The epistemological beliefs of undergraduate elementary education majors was measured using Schraw’s Epistemological Beliefs Inventory (EBI). The EBI was developed as a modification of Schommer’s Epistemological Beliefs Questionnaire (EBQ) (Schommer, 1990). The EBQ is a 63-item instrument with four subscales. The EBQ instrument was based on a multidimensional view of epistemological beliefs; that is, that “personal epistemology is a belief system that is composed of several more or less independent dimensions” (Schommer, 1990, p. 498), with approximately half of the items written so a naïve individual would agree and the other approximate half that would disagree. Therefore, the higher the score, the more naïve the individual (Duell & Schommer-Aikins, 2001). The questionnaire was designed for use with college students and has been used in studies with similar aged students. The EBQ was first developed in 1990 and originally included five subscales:

(a) innate ability; that is, ability to learn is innate, (b) simple knowledge; that is, knowledge is discrete and unambiguous, (c) quick learning; that is, learning is quick or not at all, (d) certain knowledge; that is, knowledge is certain, and (e) omniscient authority; that is, knowledge is handed down from authority rather than derived from reason. (Schommer, 1990, p. 499)

Factor analysis of the five subscales revealed that 55.8% of the variability within the questionnaire could be accounted for with four factors: (a) simple knowledge, (b) certain knowledge, (c) innate ability, and (d) quick learning and so the fifth factor, “omniscient authority” was dropped (Schommer, 1990). Schommer, Crouse, and Rhodes (1992) verified Schommer’s (1990) findings in tests they conducted. The test-retest reliability of the test for college students was found to be .74. The inter-item correlations for items within each belief factor range from .63 to .85. Content validity was achieved with screening done by professionals
in the field of educational psychology. Confirmatory factor analysis using the mean score of subsets as the variables in the analysis replicated the four-factor structure earlier arrived at in Schommer’s (1990) study (Duell & Schommer-Aikins, 2001).

Although Schommer’s EBQ has been recognized for its importance in contribution to epistemological belief research (Cheng et al., 2009; Ismail, 2016; Phan, 2008), a contradictory view about its validity was brought up by Clarebout, Elen, Luyten, and Bamps (2001) based on its lack of a theoretical framework to uphold it and on the inability of research using it to be replicated. Schraw et al. (2002) found the exclusion of the category of omniscient authority “important given that researchers have postulated a relationship between beliefs about authority and skilled reasoning” (p. 182). Schraw et al. (2002) therefore conducted research with the intent to construct an instrument that:

(a) Fit unambiguously into one of five categories that corresponded to the five hypothesized epistemic dimensions.
(b) yielded an omniscient authority factor … and to relate this factor to cognitive outcome measures,
(c) was more efficient than the EBQ, specifically by creating more homogeneous factors that explained a greater proportion of sample variations and demonstrated a higher level of criterion validity, and
(d) was shorter. (p. 182)

To do this, 160 undergraduates (104 females and 56 males) enrolled in an introductory education psychology class completed the EBQ and a 28-question EBI questionnaire. These 28 questions were shortened from an earlier 32-item version developed based on content analysis and pilot studies (Bendixen, Schraw, & Dunkle, 1998). Seven of the questions were paraphrases
of items from EBQ. All the questions were written to eliminate multiple factor loadings and had clear relationship to the relevant constructs. A Likert-type response scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used for measurement. The analysis revealed five factors with eigenvalues greater than one that explained 60% of the total sample variation: (a) Factor 1: Omniscient Authority; Eigenvalue = 1.63 (b) Factor 2: Certain Knowledge; Eigenvalue = 1.63 (c) Factor 3: Quick Learning; Eigenvalue = 1.47 (d) Factor 4: Simple Knowledge; Eigenvalue = 1.43 (e) Factor 5: Innate Ability; Eigenvalue = 1.36. (Schraw et al., 2002). Test-retest correlation values for the five factors were .66, .81, .66, .64, and .62, respectively. The results indicated that EBI adequately measures the five dimensions of epistemological beliefs originally suggested by Schommer (1990), with stability and variation explained over time (Schraw et al., 2002). That is;

- omniscience authority (Omni) – knowledge is handed down from authority rather than derived from reason,
- certain knowledge (Cert) – knowledge is certain,
- quick learning (Quick) – learning is quick or not at all,
- simple knowledge (Simp) – knowledge is discrete and unambiguous, and
- innate ability (Innate) – the ability to learn is innate (Schommer, 1990, p. 499).

The Omniscient Authority dimension consists of five questions. Scores on this factor range from 5 to 25 points. The higher the score in this dimension, the more naïve the participant’s view of omniscient authority. The reliability of the sub-scale is Cronbach’s alpha of .65. The Certain Knowledge dimension consists of six questions. Scores on this factor range from 5 to 30 points. The higher the score on this dimension, the more naïve the participant’s view of certain knowledge. The reliability of the sub-scale is Cronbach’s alpha of .63. The Quick Learning dimension consists of five questions. Scores on this factor range from 5 to 25
points. The higher the score on this dimension, the more naïve the participant’s view of quick learning. The reliability of the sub-scale is Cronbach’s alpha of .60. The Simple Knowledge subscale consists of six questions. Scores on this factor range from 5 to 30 points. The higher the score on this dimension, the more naïve the participant’s view of simple knowledge. The reliability of the sub-scale is Cronbach’s alpha of .66. Finally, the Innate Ability dimension consists of six questions. Scores on this dimension range from 5 to 30 points. The higher the score on this dimension, the more naïve the participant’s view of innate ability. The reliability of the sub-scale is Cronbach’s alpha of .63.

The combined possible score on the EBI ranges from 28 to 140 points. A score of 28 points is the lowest possible score and a score of 140 points is the highest possible score. The higher the score the more naïve the participant’s view of knowledge is. The approximate time to complete the instrument is 20 minutes. A request to use Schraw’s Epistemological Beliefs Inventory was sent to the author via email. Permission was granted by return email. See Appendix A for the email permission.

Schraw et al.’s EBI (2002) has been used in many epistemological studies. Ismail (2016) used it in a study that examined the relationship between the assessment orientation of preservice English as a foreign language (EFL) teachers’ assessment orientations and their epistemological beliefs. Phan (2008) investigated the relationship between student learning approaches (SAL) and epistemological beliefs. Cheng et al. (2009), examined epistemological beliefs of student-teachers and their conceptions of teaching. Recently, Ozturk and Yilmaz-Tuzun (2017) used the dimensions of the EBI to investigate relationships between science teachers’ epistemological beliefs and informal reasoning abilities about socioscientific issues.

Religious affinity will be measured using the Christian Fundamentalist Beliefs scale
developed by Gilbert and Francis (1996). Originally, a 139-item questionnaire was given to 866 students that attended two non-denominational state schools in Scotland. Within these 139 questions were items designed to sample fundamentalist Christian belief. Of the students that were given the questionnaire, 365 were boys and 470 were girls; 260 students were in 7th grade, 226 students were in 8th grade, 172 students were in 9th grade and 208 students were in 10th grade. The questionnaire was concerned with Christianity and science. The responses were on a 5-point Likert type scale, ranging from 5-strongly agree, through 3-not certain, to 1-disagree strongly. From these responses, correlation analysis identified the items that correlated most highly with the three key markers of Christian fundamentalist belief that were included in the questionnaire. These key markers are: “I believe that the bible is the word of God”; “I believe that Jesus really rose from the dead”; I believe that Jesus died to save me” (Gilbert & Francis, 1996, p. 251), Then, from those identified items, factor analysis and rest of test correlations identified twelve items which “cohered to produce the best homogeneous and unidimensional scale” (Gilbert & Francis, 1996, p. 251). The rest of test correlations coefficients are: I believe that God made the world in six days and rested on the seventh, r = 0.6326; I believe that the bible is the word of God, r = 0.6652; I believe that Jesus was born of a virgin, r = 0.5217; I believe that Jesus will return to earth someday, r = 0.6887; I believe in hell, 0.3704; I believe that God judges what I do and say, r = 0.6689; I believe that Jesus died to save me, 0.7736; I believe that Jesus changed real water into real wine, r = 0.7699; I believe that Jesus walked on water, 0.7770; I believe that Jesus Christ is the Son of God, r = 0.7193; I believe that God is controlling every bit of our lives, r = 0.6342; I believe that Jesus really rose from the dead, r = 0.7734. The scale had a Chronbach alpha coefficient of 0.92.

The approximate time to complete the CFBQ was five minutes. A request to use
the Christian Fundamentalist Beliefs Scale was sent to the author via email. Permission was granted by return email. See Appendix A for the email permission.

**Procedures**

The Institutional Review Board (IRB) of the university was contacted to secure permission to conduct the study. Also, the School of Education (SOE) was contacted to secure permission to use the education students in the study. After permission was obtained from these two departments, the university’s department of Analysis and Decision Support was contacted to request a list of undergraduate residential students in the elementary education program along with their emails. An email invitation to take the survey was sent to each student (see Appendix B). The email introduced the study, its importance, a request for the participation of the student with the incentive noted, and a link was provided to access the surveys. This email and the information within it contained the informed consent form.

To administer the questionnaires, the electronic survey platform, Qualtrics, was used. Qualtrics is an online survey platform that can be accessed via mobile devices, social media, or by email survey. It is the survey platform that is officially sanctioned by the university. A demographic questionnaire (see Appendix D), the questionnaires, EBI and TSSI and CFB (see Appendix C) were loaded on to this platform in random, mixed-up order. Qualtrics was set up to automatically send three follow-up reminder emails to those students who had not submitted the survey after three days. A total of one week (seven days) was allowed for the collection of completed surveys. The completion of the informed consent form and demographic questionnaire and the reading of the instructions took approximately 10 minutes. After the data was collected from Qualtrics, a person unconnected to the study removed all names and emails from the data, created a separate excel sheet, and emailed it to the researcher. The researcher
then loaded the data into SPSS for data analysis.

Completing the questionnaires and the demographic survey took an average of 10 minutes to complete. An incentive was given with the purpose of increasing the number of participants. The names of the students who completed and submitted the questionnaires were entered into a drawing for one of five $25.00 Starbucks’ gift cards. Five names were randomly drawn by a person unconnected with this study. The participants who were the recipients of the gift cards were notified via email.

**Demographics of Sample**

The population used for this study were residential students from a large, private, faith-based university in the southeastern United States that were enrolled in the Elementary Education Integrated Studies or the Special Education Integrated Studies residential program. Invitations to complete the surveys were sent to the emails of students that were enrolled in the Elementary Education Integrated Studies, or the Special Education Integrated Studies residential program, and administered via Qualtrics survey platform in May of the Spring 2018 semester. These invitations were sent to 453 students. A total of 40 completed responses were received for an 8.83% response rate. Another round of email invitations for participation and email reminders were sent out to students enrolled in the Elementary Education Integrated Studies or the Special Education Integrated Studies residential program in September at the beginning of the Fall 2018 semester to 434 students. Of these 434, an additional 29 students responded, for a total of 69 participants. This met the medium effect size at .7 statistical power level of N = 66.

**Data Analysis**

Spearman’s correlation coefficient was used to determine the strength and direction of the relationship between epistemological beliefs (predictor or independent (X) variable) and attitudes
towards science (criterion or dependent \( Y \) variable). Each of the five dimensions of epistemological beliefs of the Epistemological Beliefs Inventory; omniscient authority, certain knowledge, quick learning, simple knowledge and innate (fixed) ability (fixed knowledge), was examined for the strength and direction of its relationship to the composite score of attitudes towards science.

In order for Pearson’s product-moment correlation coefficient to be considered an appropriate statistic for determining the relationship between epistemological beliefs and attitudes towards science, five assumptions must be met. These assumptions are; the assumption of level of measurement, the assumption of independence among observations, the assumption of linear relationship, the assumption of bivariate normality, and the assumption of bivariate outliers. First, the data was screened for bivariate outliers. The assumption of bivariate outliers assumes that there are no scores that are outside of the bivariate normal distribution tested for with the histogram. A bivariate scatterplot of each dimension of epistemological beliefs to the composite score of the TSSI was visually examined to identify any outliers. A box plot graph of each dimension of epistemological beliefs to the composite TSSI-v2 score was also made to specifically identify outliers. Identification of any outliers resulted in further consideration about whether to keep, modify, or remove the score(s) from the data (Warner, 2013).

The assumption of level of measurement assumes that the variables of attitudes towards science and epistemological beliefs are measured on an interval or ratio level. Warner (2013) says that “the scores on both \( X \) and \( Y \) should be quantitative and normally distributed” (p. 267). For this study, the measurement was done using a Likert-type rating scale which does not have a true equal interval difference between scores. However, although it is controversial, it is
common to apply Pearson correlation for analysis with this type of a scale (Warner, 2013, p. 268).

The assumption of independent observation assumes that each attitude towards science \((X)\) score is independent of every other \((X)\) score, and that each epistemological beliefs \((Y)\) score is independent of every other \((Y)\) score. Examination of a bivariate scatter plot for each dimension of epistemological beliefs to a composite TSSI score showed that this assumption has been met.

The assumption of linear relationship assumes that the scores obtained for the independent (predictor) variable \((X)\), in this case epistemological beliefs, are linearly related to the scores obtained for the dependent (criterion) variable \((Y)\) variable, in this case the composite attitudes towards science score. Pearson’s \(r\) “does not effectively detect curvilinear or nonlinear relationship” (Warner, 2013, p. 268). Preliminary testing for this assumption was done by examination of the bivariate scatter plots with a fit line drawn that shows a scatter plot for each dimension of the independent or predictor variable (epistemological beliefs) and the dependent or criterion variable (attitudes towards science), to assess whether relationships are linear or not (Green & Salkind, 2014).

The assumption of bivariate normal distribution assumes that each variable is “normally distributed at all levels of the other variable” (Green & Salkind, 2014, p. 233). A histogram of the frequency of each dimension of epistemological beliefs (the independent or criterion variable) was examined for the classic bell curve that indicates normal distribution. Each scatter plot was, again, examined for the classic “cigar shape” pattern of the data points that is an indication of normal distribution of variables.
The assumption of bivariate outliers (bivariate normality) assumes that there are no scores outside of the bivariate normal distribution. Each dimension of the independent or criterion variable epistemological beliefs were examined with a histogram to check for a classic bell curve pattern that indicates normal distribution of responses.

The Pearson product-moment correlation coefficient indicates the “strength of an observed relationship between two or more measured variables” (Gall et al., 2007, p. 639) or the effect size. Three statistics were examined; effect size (strength of the relationship), level of significance, and directionality. Effect size was measured using Pearson r. An alpha level was set at .05 \((p = .05)\) which reflects that there are 5 out of 100 times that the value obtained by the sample statistic is due to chance (Creswell, 2012). Because five measures were taken from one instrument, a Bonferroni correction was made. Thus, alpha of .05 divided by 5 adjusted the alpha level to .01. A two-tailed test was used to determine significance. An r-stat of positive or negative determined directionality and effect size. This analysis was conducted using the SPSS statistical software program for Windows and Macintosh (Green & Salkind, 2014).
CHAPTER FOUR: FINDINGS

Overview

The purpose of this quantitative correlation design study was to examine the relationship between the dimensions of epistemological beliefs of undergraduate elementary education majors at a large, private, faith-based university in the southeastern United States as measured by Schraw et al.'s (2002) Epistemological Beliefs Inventory (EBI) scale and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2 (TSSI-v2). Spearman’s rho correlation coefficient was used to evaluate the null hypothesis.

Chapter Four provides a comprehensive analysis of the research study results. After a restating of the research question and hypotheses, the first section of this chapter provides a descriptive analysis of the characteristics of the 69 participants in this survey collected along with the survey. The second and third sections specifically address the research question and hypothesis and additional analysis of related correlations of interest. The fourth section provides a summary of the findings.

Research Questions

This study investigated the following research question:

**RQ1**: Is there a relationship between the epistemological beliefs of undergraduate elementary education majors and their attitudes towards science?

Hypotheses

The null hypotheses for this research study were:

**$H_01$**: There is no statistically significant correlation between epistemological beliefs about omniscient authority of undergraduate elementary education majors as measured by

**H₀2:** There is no statistically significant correlation between epistemological beliefs about certain knowledge of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**H₀3:** There is no statistically significant correlation between epistemological beliefs about quick learning of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**H₀4:** There is no statistically significant correlation between epistemological beliefs about simple knowledge of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**H₀5:** There is no statistically significant correlation between epistemological beliefs about innate (fixed) ability of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

**Descriptive Statistics**

Three instruments were used to collect data for this study. The predictor (or independent) variables in this study were the individual dimensions of epistemological beliefs of the elementary education majors. These were assessed using Schraw et al.’s (2002) Epistemological Beliefs Inventory (EBI). This questionnaire is divided into five dimensions: omniscient
authority, certain knowledge, quick learning, simple knowledge, and innate (fixed) ability. A five-point Likert scale was used to numerically identify each of these five dimensions. A score of one identifies a naïve view of knowledge; that is that knowledge is discrete not changing. A score of five identifies a complex or mature view of knowledge. The mean ($M$), standard deviation ($SD$), and variance ($s^2$) of each of the dimensions as well as of the overall score was determined. The mean, standard deviation and variance for each dimension were: omniscient authority ($M = 3.30, SD = .55, s^2 = .31$), certain knowledge ($M = 3.12, SD = .51, s^2 = .26$), quick learning ($M = 1.83, SD = .53, s^2 = .29$), simple knowledge ($M = 2.63, SD = .47, s^2 = .22$), innate (fixed) ability ($M = 2.62, SD = .62, s^2 = .39$). Table 2 summarizes this data.

Table 2

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Mean ($M$)</th>
<th>Standard Deviation ($SD$)</th>
<th>Variance ($s^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omni</td>
<td>3.30</td>
<td>.55</td>
<td>.31</td>
</tr>
<tr>
<td>Cert</td>
<td>3.12</td>
<td>.51</td>
<td>.26</td>
</tr>
<tr>
<td>Quick</td>
<td>1.83</td>
<td>.53</td>
<td>.29</td>
</tr>
<tr>
<td>Simp</td>
<td>2.63</td>
<td>.47</td>
<td>.22</td>
</tr>
<tr>
<td>Innate</td>
<td>2.62</td>
<td>.62</td>
<td>.39</td>
</tr>
</tbody>
</table>

The criterion (or dependent) variable in this study, attitudes towards science, was assessed using Cobern’s (2005) Thinking about Science Survey Instrument-v2. The TSSI-v2 instrument divides attitudes towards science into nine categories; epistemology (EPIST), science and the economy (ECON), science and the environment (ENVIR), public policy and science (POLY), science and public health (HEAL), science, religion, and morality (RELIG), science,
emotions, and aesthetics (BEAUT), science, race, and gender (RACE), and science for all (For_All) (Cobern, 2005). The individual attitudes towards science of these categories were scored with a five-point Likert-type scale; a score of one identified the participant as having the least positive and/or most negative attitude towards the “commonly held worldview of science portrayed in the medial and in popular science and science education literature” (Cobern & Loving, 2002, p. 1016), and a score of five identified the participant as have the most favorable or least negative attitude towards the “commonly held worldview of science portrayed in the medial and in popular science and science education literature” (Cobern & Loving, 2002, p. 1016).

The mean \(M\), standard deviation \(SD\), and variance \(s^2\) of each of the categories as well as of that of the overall score was determined. The mean, standard deviation and variance for each category were: epistemology \(M = 2.60, SD = 1.02, s^2 = 1.04\), science and the economy \(M = 4.25, SD = .33, s^2 = .11\), science and the environment \(M = 4.09, SD = .42, s^2 = .18\), public policy and science \(M = 2.93, SD = .71, s^2 = .51\), science and public health \(M = 4.17, SD = .59, s^2 = .34\), science, religion, and morality \(M = 1.81, SD = .66, s^2 = .43\), science, emotions, and aesthetics \(M = 3.21, SD = .58, s^2 = .34\), science, race, and gender \(M = 3.58, SD = 1.21, s^2 = 1.47\), science for all \(M = 4.14, SD = .46, s^2 = .21\), composite Thinking about Science Survey scores \(M = 3.43, SD = .25, s^2 = .07\). Table 3 summarizes this data.
Table 3

*Mean, Standard Deviation and Variance of the Categories and overall totals of the Thinking About Science Survey Instrument*

<table>
<thead>
<tr>
<th></th>
<th>Mean (M)</th>
<th>Standard Deviation (SD)</th>
<th>Variance (s^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPIST</td>
<td>2.60</td>
<td>1.02</td>
<td>1.04</td>
</tr>
<tr>
<td>ECON</td>
<td>4.25</td>
<td>.33</td>
<td>.11</td>
</tr>
<tr>
<td>ENVIR</td>
<td>4.09</td>
<td>.42</td>
<td>.18</td>
</tr>
<tr>
<td>POLY</td>
<td>2.93</td>
<td>.71</td>
<td>.51</td>
</tr>
<tr>
<td>HEAL</td>
<td>4.17</td>
<td>.59</td>
<td>.34</td>
</tr>
<tr>
<td>RELIG</td>
<td>1.81</td>
<td>.66</td>
<td>.43</td>
</tr>
<tr>
<td>BEAUT</td>
<td>3.23</td>
<td>.59</td>
<td>.35</td>
</tr>
<tr>
<td>RACE</td>
<td>3.58</td>
<td>1.21</td>
<td>1.47</td>
</tr>
<tr>
<td>For_All</td>
<td>4.14</td>
<td>.46</td>
<td>.21</td>
</tr>
<tr>
<td>TSSI</td>
<td>3.43</td>
<td>.26</td>
<td>.07</td>
</tr>
</tbody>
</table>

The third instrument used in the study was the Christian Fundamentalist Beliefs Questionnaire. The individual Christian fundamental beliefs were scored with a five-point Likert-type scale; a score of one identified the participant as not affiliating with the basic tenets of Christian fundamental beliefs and a score of five identified the participant having a high affiliation with the Christian fundamental beliefs. The mean, standard deviation and variance of the participants in this study were, ($M = 4.80$, $SD = .24$, $s^2 = .06$). Table 4 summarizes this data.
Table 4

Mean, Standard Deviation and Variance of Christian Fundamentalist Beliefs Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>s²</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFBQ</td>
<td>4.81</td>
<td>.23</td>
<td>.06</td>
</tr>
</tbody>
</table>

Results

Statistical analysis of the data for the research question was intended to be run using the Pearson product-moment correlation coefficient. Preliminary data screening was conducted to ensure that there were no errors in the data and that the assumptions associated with the Pearson product-moment correlation coefficient were met.

Assumption Tests

Four assumptions have to be met in order to qualify for analysis using the Pearson product-moment correlation coefficient. These assumptions are the assumption of bivariate normal distribution (assessed with scatterplots), the assumption of linear relationship (assessed with scatterplots), the assumption of bivariate outliers (assessed with scatterplots), and the assumption of normality (assessed with histograms and Kolmogorov-Smirnov).
The assumption of linear relationship assumes that the scores obtained for the independent predictor variables of dimensions of epistemological beliefs (X scores), are linearly related to the scores obtained for the composite attitudes towards science (Y scores) (Green & Salkind, 2014, p. 236). This is a necessary preliminary test because, Pearson’s $r$ “does not effectively detect curvilinear or nonlinear relationship” (Warner, 2013, p. 268). Preliminary testing for this assumption was conducted by examination of the scatter plots (Figure 1). A scatter plot for each predictor variable (omniscient authority, certain knowledge, quick learning, simple knowledge, and innate (fixed) ability) and the criterion variable (attitudes towards science) was obtained along with a fit line at total (Figure 1), to assess whether relationships are linear or not. Examination of the scatter plot between the composite TSSI-$\nu$2 score and
omniscient authority shows a questionable linear relationship. Examination of the scatterplots between the composite score of TSSI-ν2 and certain knowledge, composite score of TSSI-ν2 and quick learning and composite score of TSSI-ν2 and innate (fixed) ability show a very slight and improbable positive linear relationship. The scatterplot of TSSI-ν2 and simple knowledge shows a slight and improbable negative linear relationship. The assumption of linear relationship is considered to not have been met.
The assumption of bivariate normal distribution was also assessed by examination of the scatter plots (Figure 1) between each epistemological belief dimension ($X$) scores and the composite TSSI-$v_2$ scores ($Y$). Scatterplots examined for bivariate normal distribution should reveal a classic “cigar shape” that can be seen when distribution is normal. This cigar shape is possibly, but not clearly, indicated in the graph of the composite TSSI-$v_2$ score vs omniscience authority dimension of epistemological beliefs. However the scatterplots of the composite TSSI-$v_2$ score vs certain knowledge, composite TSSI-$v_2$ score vs quick learning, composite TSSI-$v_2$ vs simple knowledge, and composite TSSI-$v_2$ score vs innate (fixed) knowledge do not reveal the “cigar shape” even to a slight extent. Besides bivariate normal distribution, Warner (2013) says that “this assumption also implies that there should not be extreme bivariate outliers” (p. 269). Warner (2013) says that “Pearson’s $r$ is not robust to the effect of extreme outliers, and the impact of outliers is greater when the N of the sample is small” (p. 275). On examination of the scatterplots, quite a few outliers can be seen. Mostly, these are not extreme outliers, but because the number of participants is small, these make a big difference and result in the relationship really not showing up as being linear. Warner (2013) says that “Pearson’s $r$ can be an inaccurate
description of the strength of the relationship between X and Y when there are one or several outliers” (p. 270). To adjust for this, Spearman’s rho was run. Warner (2013) said that “…to get rid of problems such as…outliers, then Spearman r may be used” (p. 316). For this study, examination of scatterplots to determine if the assumptions that are necessary in order to run Pearson’s r product-moment correlation coefficient are met, revealed that Spearman’s rho is a better fit for analysis of the data.

Examination of the histograms to look test for the assumption of normality shows that scores for each of the epistemological belief dimensions as well as for the TSSI-v2 are basically normally distributed. They each have a few scores that fall outside the bell curve but for the most part fall within it. Warner (2013) said that “For each value of X, values of Y should be approximately (italics are mine) normally distributed” (p. 269). However, because of the low numbers of participants, further analysis for normality was done using Kolmogorov-Smirnov for each of the dimensions of epistemological beliefs and the TSSI-v2 (Table 4). Significance on the Kolmogorov-Smirnov test indicates that distribution is significantly different from normal distribution; that the assumption of normality is not met. Results of this analysis showed significance for Omniscience Authority: \( p = .00 \), Certain Knowledge: \( p = .01 \) and Simple Knowledge: \( p = .000 \). These results indicate that the distribution for those three are significantly different from a normal distribution (Table 5). Quick learning: \( p = .03 \), and innate (fixed) ability: \( p = .03 \) are narrowly non-significant. But based on \( p \leq .05 \) being significant, analysis indicates that these are non-significant in the KS analysis and therefore the scores are considered to be normally distributed. The distribution of responses to the TSSI-v2 were significant; \( p = .200 \). This indicates that these responses to the TSSI-v2 questions are normally distributed. Based on
the assumption tests, correlation analysis was continued using Spearman’s \( \rho \) instead of Pearson’s \( r \) correlation coefficient.

Table 5

\textit{Kolmogorov-Smirnov Test for Assumption of Normality for Each Dimension of Epistemological Beliefs Inventory and the Composite Score of TSSI-v2}

<table>
<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>( N )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omni</td>
<td>.137</td>
<td>69</td>
<td>.003</td>
</tr>
<tr>
<td>Cert</td>
<td>.122</td>
<td>69</td>
<td>.012</td>
</tr>
<tr>
<td>Quick</td>
<td>.114</td>
<td>69</td>
<td>.027</td>
</tr>
<tr>
<td>Simp</td>
<td>.157</td>
<td>69</td>
<td>.000</td>
</tr>
<tr>
<td>Innate</td>
<td>.111</td>
<td>69</td>
<td>.034</td>
</tr>
<tr>
<td>TSSI</td>
<td>.086</td>
<td>69</td>
<td>.200*</td>
</tr>
</tbody>
</table>

\textit{Note.} This is a lower bound of the true significance.

\textbf{Hypotheses}

To test the relationship between the attitudes that elementary education majors have to different dimensions of epistemological beliefs, analysis was done using Spearman’s \( \rho \) to account for lack of an obvious linear relationship and due to outliers. Spearman’s \( \rho \) was computed using SPSS software. Table 6 summarizes the results for each dimension of the EBI.
Table 6

*Spearman’s rho Correlation Coefficient for the Relationship Between Attitudes Towards Science and Dimensions of Epistemological Beliefs*

<table>
<thead>
<tr>
<th></th>
<th>Omniscient Authority</th>
<th>Certain Knowledge</th>
<th>Quick Learning</th>
<th>Simple Knowledge</th>
<th>Innate (Fixed) Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSSI</td>
<td>Spearman’s rho</td>
<td>.16</td>
<td>-.013</td>
<td>-.03</td>
<td>.01</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.20</td>
<td>.92</td>
<td>.82</td>
<td>.84</td>
<td>.93</td>
</tr>
<tr>
<td>N</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

Null Hypothesis One

Null Hypothesis One states that there is no statistically significant correlation between epistemological beliefs about omniscient authority of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured Cobern’s (2005) Thinking about Science Survey Instrument-νs2. Spearman’s rho correlation coefficient between the composite score of the TSSI-νs2 and Omniscient Authority, is $r(68) = .16, p < .20$ (Table 7). The relationship between the two is not statistically significant. Null Hypothesis One was not rejected based on the data collected in this study.

Table 7

*Spearman’s rho Correlation Coefficient for the Relationship Between Attitudes Towards Science and Omniscient Authority*

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s rho</td>
<td>.16</td>
<td>.20</td>
<td>69</td>
</tr>
</tbody>
</table>

Null Hypothesis Two

Null Hypothesis Two states that there is no statistically significant correlation between epistemological beliefs about certain knowledge of undergraduate elementary education majors
as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey-v2. The Spearman’s rho correlation coefficient between the composite score of the TSSI and certain knowledge was $r(68) = -0.01, p = .92$ (Table 8). The relationship between the two is not statistically significant. Null Hypothesis Two was not rejected based on the data collected in this study.

Table 8

*Spearman’s rho Correlation Coefficients for the Relationship Between Attitudes Towards Science and Certain Knowledge*

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s rho</td>
<td>-.01</td>
<td>.92</td>
</tr>
</tbody>
</table>

**Null Hypothesis Three**

Null Hypothesis Three states that there is no statistically significant correlation between epistemological beliefs about quick learning of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2. Spearman’s rho correlation coefficient between the composite score of the TSSI and quick learning, were $r(68) = -.03, p < .82$ (Table 9). The relationship between the two is not statistically significant. Null Hypothesis Three was not rejected based on the data collected in this study.

Table 9

*Spearman’s rho Correlation Coefficient for the Relationship Between Attitudes Towards Science and Quick Learning*

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s rho</td>
<td>-.03</td>
<td>.82</td>
</tr>
</tbody>
</table>
Null Hypothesis Four

Null Hypothesis Four stated that there is no statistically significant correlation between epistemological beliefs about simple knowledge of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

The Pearson’s product-moment correlation coefficient and the Spearman’s $\rho$ correlation coefficient between the composite score of the TSSI and simple knowledge, was $r(68) = -.03$, $p < .84$ (Table 10). The relationship between the two is not statistically significant. Null Hypothesis Four was not rejected based on the data collected in this study.

Table 10

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s rho</td>
<td>-.03</td>
<td>.84</td>
<td>68</td>
</tr>
</tbody>
</table>

Null Hypothesis Five

Null Hypothesis Five states that there is no statistically significant correlation between epistemological beliefs about innate (fixed) ability of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2.

The Spearman’s $\rho$ correlation coefficient between the composite score of the TSSI-v2 and Omniscient Authority was $r(68) = -.01$, $p < .93$ (Table 11). The relationship between the
two is not statistically significant. Null Hypothesis Five was not rejected based on the data collected in this study.

Table 11

*Pearson’s r and Spearman’s rho Coefficients for the Relationship Between Attitudes Towards Science and Innate Ability (Fixed Learning)*

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s rho</td>
<td>.01</td>
<td>.93</td>
<td>68</td>
</tr>
</tbody>
</table>

Based on the use of the Spearman’s *rho* correlation coefficient which determines nonparametric correlations to determine the relationships between the individual dimensions of epistemological beliefs and the composite score of the TSSI-ν2, none of the null hypotheses could be rejected. In other words, in this research study using TSSI-ν2 and EBI there is no indication that there is a statistically significant relationship between any of the dimensions of epistemological beliefs of the EBI and the attitudes towards science using the composite score of the Thinking About Science Survey Instrument-ν2.
CHAPTER FIVE: CONCLUSIONS

Overview

The first section of this chapter discusses the results of the research in light of other literature on the subject and Bandura’s Cognitive Theory and in relation to Fulmer’s study. The second section discusses the implication of the acceptance of the null hypotheses to teacher education programs, and education itself. The third section discusses the limitations to the study based on the low number of participants and the questionable use of the instrument. Finally, the last section discusses recommendations for further study that may be a better fit for the use of the TSSI and also expansions to this study that may yield correlation coefficients that are considered significant.

Discussion

The purpose of this correlation research study was to determine if there is a relationship between each of the five individual dimensions of epistemological beliefs and the composite score of attitudes towards science of elementary education majors from a large, private, faith-based university in the southeastern United States. This was done by replicating an earlier study done by Fulmer (2014) in which the relationship between epistemological beliefs and attitudes towards science of undergraduate university students at a large, public university in the eastern United States was measured with the use of the same instruments. The criterion variable was attitudes towards science. In this study, attitudes towards science are attitudes towards the “commonly held worldview of science portrayed in the medial and in popular science and science education literature” (Cobern & Loving, 2002, p. 1016), or “the balance and valuations people hold about science in the context of several other culturally and socially – but not scientific per se – important issues” (Cobern, 2001, p. 49). Attitudes towards science was
measured using Cobern’s Attitudes Towards Science Survey Instrument-v2 (Cobern, 2005). The predictor variables were the individual dimensions of epistemological beliefs; omniscient authority, certain knowledge, quick learning, simple knowledge, and innate (fixed ability). These were defined as; omniscience authority (Omni) – knowledge is handed down from authority rather than derived from reason, certain knowledge (Cert) – knowledge is certain, quick learning (Quick) – learning is quick or not at all, simple knowledge (Simp) – knowledge is discrete and unambiguous, and innate (fixed) ability (Innate) – the ability to learn is innate (Schommer, 1990, p. 499). These dimensions were measured using Schraw et al.’s (2002) Epistemological Beliefs Inventory. Additionally, to confirm the Christian beliefs indicated in the demographics collected at the introduction of the study, the Christian Fundamentalist Belief scale (Gilbert & Francis, 1996) was used.

Previous studies have shown that there is a link between epistemological beliefs and attitudes towards science (Fulmer, 2014; Kilinc & Seymen, 2014; Ozturk & Yilmaz-Tuzun, 2017; Yilmaz-Tuzun & Topcu, 2008). However, in this study, analysis using Spearman’s rho failed to find a relationship between any of the dimensions of epistemological beliefs and attitudes towards science.

**Null Hypothesis One**

The null hypothesis one states that there is no statistically significant correlation between epistemological beliefs about omniscient authority of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured using Cobern’s (2005) Thinking about Science Survey Instrument-v2. The results of this study indicated that the null hypothesis one could not be rejected; that there is no significant relationship between epistemological beliefs about
omniscient authority and attitudes towards science. This is contrary to recent literature by Fulmer (2014), who found positive relationship was between the omniscient authority dimension of the EBI and a category that he called *non-religious* which he gleaned from Cobern’s (2005) TSSI-v2 instrument and a category that he called *science-positive* which he also gleaned from Cobern’s (2005) TSSI-v2 instrument and used to measure positive attitudes towards science (p. 202).

In Fulmer’s (2014) study, the sub-category of questions of the TSSI-v2 that Cobern labeled Science, Religion and Morality was described as such:

> The third TSSI subscale includes items about the perceived discrepancy between science and religious knowledge, such as ‘Science is a more important source of knowledge than religion’; so it is called *non-religious*. This scale measures the extent to which individuals perceive science to be discrepant with religion or even at odds with it. (p. 202)

Cobern and Loving (2002) however, says of the categories that they “are not intended to represent an authoritative scientific worldview, but a scientific worldview version commonly found in both the popular media and the popular literatures of science and science education” (p. 1020). He describes the popular notion of category of Science, Religion, and Morality being that,

> People make moral choices about the use of scientific findings but science itself is morally neutral. Science is also neutral with regard to religion. The importance of science, however, is such that science must be protected from the intrusive actions of some religions. (Cobern & Loving, 2002, p. 1021)
The response to the questions in this category indicate not if students perceive science to be religious or non-religious, but whether they agree with this popular notion that science is non-religious. And a low number in this category does not indicate that a participant thinks that science is non-religious or that he has a negative attitude if he perceives science to be religious, but rather that he doesn’t agree with the popular notion of science that it is religiously neutral and needs to be protected from religion. Evaluated in the light of this intent, Fulmer (2014) found a positive relationship between an attitude of science that did not agree that science was neutral or in opposition to religion and omniscient authority, even more so interestingly, because Fulmer’s group of participants do not claim to hold Christian beliefs. Because this study’s group of participants have predominantly fundamentalist Christian beliefs as indicated with the CFBS (Table 3), this is the relationship that was also expected to be found between attitudes towards science and omniscient authority. The fact that no relationship was found may be due to the composite score being used for TSSI-v2 instead of using the subcategories. This is an area that should be further investigated.

Also, Fulmer (2014) suggested that omniscient authority in the case of his participants referred to “university faculty rather than epistemic authorities outside of the academic setting” (p. 204). This suggestion was to explain how participants that didn’t believe science to be religious in nature could believe in an omniscient authority. The findings of this study, using participants with predominantly fundamentalist Christian beliefs, throws questions upon that definition. One of the tenets of fundamentalist Christian beliefs is a belief in God as the authority of our lives and that He is the creator of life. The participants in this study would be expected to have a strong positive relationship between omniscient authority and attitudes toward science. The absence of a correlation in this study, especially in the direction indicated by
previous studies, and given the religious views of this participant group, requires some
discussion. Ultimately, it indicates that students that believe in an omniscient authority, although
this does not result in a positive attitude toward science, also does not result in negative views
toward the popular portrayals of science as a whole. This is contrary to what many think about
Christians’ attitudes towards science. But it does support the results of the study done by Cobern
et al. (2013) that evidence does “not show that anti-science sentiment increases with increasing
Christian belief. Subjects with strong Christian beliefs were found to be just as supportive of
science, if not more so, than subjects with no Christian beliefs” (p. 488).

The results also support Bandura’s Cognitive theory which explains that relationships of
“behavior, environmental influences, personal factors such as cognitive factors all operate to be
interactive determinants of each other (Bandura, 1986, p. 23). In other words, it may be
impossible to simplify any behavior to one simple predictor/criterion relationship, but is rather
the result of many influences that all affect each other.

**Null Hypothesis Two**

The null hypothesis two stated that there is no statistically significant correlation between
epistemological beliefs about the certainty of knowledge of undergraduate elementary education
majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their
attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey
Instrument-v2. The results of this study indicated that this null hypothesis could not be rejected,
and that there is no significant relationship between epistemological beliefs about the certainty of
knowledge and attitudes towards science.

This is also contrary to previous research results. Fulmer (2014) found a *negative*
relationship between attitudes towards science and epistemological beliefs of certain knowledge.
He said that “students have more positive attitude toward science…when they believe that knowledge is uncertain”, and that “attitudes are negatively related to certainty” (Fulmer, 2014, p. 203). His expectations were that the same relationship would exist between attitudes towards science and certain knowledge as did between attitudes towards science and omniscient authority. He said that,

One may expect that certainty and religiosity should align with authority – considering the cultural role of religious institutions as sources of authority and seminal work that shows positive relationships between religiosity and acceptance of authority. (Fulmer, 2014, p. 202)

In this study, there was no relationship found between attitudes of science and either omniscient authority or certain knowledge. This could be the consistent aligning that Fulmer (2014) was expecting, although without the negative relationship. Additional research or analysis of the data needs to be done to determine if using only the scores from the questions from the Science, Religion and Morality sub-category are related positively or negatively to omniscient authority and certain knowledge. The fact that no negative relationship was indicated in this study breaks down this commonly held misconception that those that believe in absolutes do not have positive science attitudes. It can also be an indication that, as Bandura sought to explain in his CT, there are many factors that interact to produce any particular behavior (Bandura, 1986, p. 23).

**Null Hypothesis Three**

The null hypothesis three stated that there is no statistically significant correlation between epistemological beliefs about quick learning of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their
attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2. The results of this study indicated that the null hypothesis three could not be rejected; that there was no significant relationship between epistemological beliefs about quick learning and attitudes towards science. The quick learning dimension of epistemological beliefs is that if a person is going to learn something, he will learn it quickly. Using the EBI, this dimension been found to be related to the student expectations of teachers (Yilmaz-Tuzun & Topcu, 2008) and reasoning abilities of pre-service science educators (Ozturk & Yilmaz-Tuzun, 2017).

Because the study of science contains so many facets of memorization and conceptual learning, it could perhaps be expected that a negative relationship would exist between attitudes towards science and epistemological beliefs about quick learning. In other words, if a participant thought that learning should be quick he would not have a positive attitude towards science. However, analysis of the data from this study did not show that there is a relationship between the two at all (Table 7). The fact that this study indicates that for this group of participants there is no relationship between the two, indicates an ability of educators to appreciate science in spite of the difficulty factor involved. Or their fundamentalist Christian beliefs lead to an appreciation of science that is based more on their relationship to the Creator rather than their views on the ways in which students learn. This signifies again, that as Bandura’s CT suggests (1986) there are many factors that contribute to the behavior and attitudes of people and that it is more complicated than a predictor/criterion relationship.

**Null Hypothesis Four**

The null hypothesis four states that there is no statistically significant correlation between epistemological beliefs about simple knowledge of undergraduate elementary education majors
as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2. The results of this study indicated that the null hypothesis four could not be rejected; that there is no significant relationship between epistemological beliefs about simple knowledge and attitudes towards science.

A study by Yilmaz-Tuzun and Topcu (2008) found a relationship between the epistemological worldviews of the preservice science teachers and their beliefs of simple knowledge. Yilmaz-Tuzun and Topcu (2008) stated that “teachers who believed the effectiveness of student-centered teaching approaches in student learning tended to feel that science may be best taught when students memorize the isolated facts or the body of scientific knowledge” (p. 76). Based on this previous literature, it could be expected that there would be a negative relationship between the EBI dimension of simple knowledge and attitudes towards science. Because science is not simple and not all the component parts and concepts can be learned by simple memorization of facts, could lead to a negative attitude towards science. The results of this study did not indicate that such a relationship exists. This could be an indication of the same things as proposed with the lack of a relationship between epistemological beliefs about quick learning and attitudes towards science. That is that these elementary educators have the ability to appreciate science in spite of the fact that not all science is simple and involves more complex methods of learning than simply memorizing. Or that the fundamentalist Christian beliefs of these participants lead to an appreciation of science that is based more on their relationship to the Creator rather than their views on the ways in which students learn. In any case, it further supports Bandura’s CT (1986) that explains that many factors contribute to the behavior and attitudes of people and that it is more complicated than a predictor/criterion relationship.
Null Hypothesis Five

The null hypothesis five states that there is no statistically significant correlation between epistemological beliefs about innate (fixed) ability of undergraduate elementary education majors as measured by Schraw et al.’s (2002) Epistemological Beliefs Inventory and their attitudes towards science as measured by Cobern’s (2005) Thinking about Science Survey Instrument-v2. The results of this study indicated that the null hypothesis five could not be rejected; that there was no significant relationship between epistemological beliefs about innate (fixed) ability and attitudes towards science.

Research indicates that there is a relationship between the innate (fixed) ability dimension of epistemological beliefs and science teachers’ attitudes towards learning and towards how they teach. Results of research done by Ozturk and Yilmaz-Tuzun (2017) indicated a relationship between epistemological beliefs about innate (fixed) ability and informal reasoning abilities in socioscientific issues. They said that “there were significant negative correlations between the prescience teachers’ total argument constructions and their [epistemological beliefs about] innate abilities…individuals holding beliefs that ability to learn is genetically determined rather than acquired through education and experience…offered fewer arguments” (Ozturk & Yilmaz-Tuzun, 2017, p. 1297). Yilmaz-Tuzun and Topcu (2008) found a relationship between science teachers’ outcome expectancies of their students and the teachers’ innate (fixed) ability belief. The science teachers who believed “that their students would do well in science tended to see their students’ learning ability as not fixed” (Yilmaz-Tuzun & Topcu, 2008, p. 76). Attempts to establish a relationship between the innate (fixed) ability dimension of epistemological thinking and attitudes towards science in this study were not successful. For the third time, this could be indications of the same things as proposed concerning the relationship between the previous two
dimensions of epistemological beliefs (quick learning and simply knowledge) and attitudes towards science. That is that, regardless of elementary educators’ beliefs of if knowledge is fixed, they can separate this belief from their attitudes towards science. And again, that the fundamentalist Christian beliefs of these participants lead to an appreciation of science that is based more on their relationship to the Creator rather than their views on the abilities of their students to learn. In any case, it further supports Bandura’s CT (1986) that explains that many factors contribute to the behavior and attitudes of people and that it is more complicated than a predictor/criterion relationship.

Implications

Epistemological beliefs have been found to affect the way in which science teachers teach and their expectations of their students (Ozturk & Yilmaz-Tuzun, 2017; Yilmaz-Tuzun & Topcu, 2008). Specifically in the area of science, Yilmaz-Tuzun and Topcu (2008) stated that “teachers play a central role to improve the effectiveness of science instruction. Their epistemological beliefs will certainly affect the way they teach” (p. 81). As previous studies have indicated that attitudes that teachers have towards a subject affects their students attitudes towards that subject (Denessen et al., 2015) and so the students subsequent achievement in the subject (Odom & Bell, 2015), it is important to find the factors that affect the teachers’ attitudes. The implications of the results of this study speak to the kinds of educators that are produced in this university’s elementary education program, particularly as it relates to science. The implication based on this study is that no additional attention should be spent on the program with regard to epistemological beliefs to improve the elementary educators’ attitudes towards science. Extending the results to other the elementary education majors programs may or may not be implied. If we take out the element of the fundamentalist Christian beliefs which is not
necessarily a given, then it may be implied that basically future educators can understand and appreciate the value of science beyond what they may think about the way in which students’ learn and where knowledge comes from. This is an encouraging implication because of the relationship between teachers’ attitudes and students’ attitudes (Denessen et al., 2015).

Furthermore, the evidence that fundamentalist Christian beliefs do not result in negative attitudes overall to the popular Model of science can help to change incorrect perceptions in this area. This group overall had a positive attitude towards the popular Model of science as can be seen by the composite score of 3.31 (see Table 2). Elementary education majors with fundamentalist Christian beliefs may have different epistemological beliefs than those that aren’t Christians, especially in the area of omniscient authority and certainty of knowledge, but these do not affect their attitudes towards the modern Model of science. This information could level the playing field as far as hiring practices of government run schools of educators coming out of faith-based Universities.

**Limitations**

The number of participants (n = 69) in this study was just above the number necessary to satisfy a statistical power of .7 at .05 level of significance (n = 66) (Creswell, 2012, p. 195). Even with meeting that power, Warner (2013) stated that “It is advisable to have an N of at least 100 for any study where correlations are reported” (p. 275). Based on this, the number of participants in the study may not have been enough to “treat the results as ‘findings’” (Warner, 2013, p. 275) one way or the other. Also, outliers have much more influence when the number of participants is small (Warner, 2013). Although extreme outliers were only identified by scatterplot in the relationship between attitudes towards science and quick learning, all of the scatterplots show possible outliers that could affect the results given that Spearman’s *rho* is not
only not robust to extreme outliers, but that even less extreme outliers have influence that could affect the results (Warner, 2013, p. 275).

By far, the largest percentage of the participants in this study were female (Table 1). Although research results are mixed as to the relationship between gender and science attitudes, the results of many studies do indicate that pre-service females have less positive attitudes towards science than males (Ambusaidi & Al-Farei, 2017; Buaraphan, 2011; Ilhan et al., 2015). Fulmer’s (2014) study with undergraduates in a large public university indicated that females had a significantly less positive attitude towards science than did males. This, then, is a limitation when extrapolating this group of participants to a larger population of elementary education majors. This is a sampling error limitation that could have resulted in a correlation if the gender population had been more equal to the overall elementary education major population.

Another limitation was the way in which Cobern’s TSSI-v2 was used in this study. The TSSI is meant to be used to measure the responses that different populations have to a “scientific worldview version commonly found in both the popular media and the literatures of science and science education” (Cobern, 2001, p. 9). It is meant to be used to “compare the ideas held by different groups” (Cobern, 2001, p. 49). Given that its intended use was not as this study used it, it could well be that the results of the study cannot be relied upon.

**Recommendations for Further Research**

Further research into the ways in which the dimensions of epistemological thinking is related to attitudes towards science could be done using a different attitudes instrument and compared to the data collected in this study using the Thinking About Science Survey Instrument (TSSI). The TSSI measures the responses that participants have to a “scientific worldview version commonly found in both the popular media and the literatures of science and science
education” (Cobern, 2001 p. 9). It is meant to be used to “compare the ideas held by different groups” (Cobern, 2001, p. 49). With this in mind, the data that was collected in this study could be used to compare with data collected from other participant groups to determine agreement or disagreement with the popular Model of science. In Cobern and Loving’s (2002) study that used TSSI to test pre-service elementary teachers attitudes towards the Model of science as portrayed in the media and well-known sources of science education literature, it was concluded that “although they have reservations about some features of the Model…by no means are they negative to science with regard to these categories” (Cobern & Loving, 2002, p. 1025). Since this study also showed that overall the attitudes weren’t negative to the Model of Science (Table 1), it would be interesting to compare the subcategory means of the TSSI-\(v_2\) from this population with other tested populations.

Related to this, because Fulmer (2014) only used three of the subcategories within Cobern’s (2005) TSSI-\(v_2\), further comparison could be done with the data obtained in this study to determine if the more secular population in that study and the fundamentalist Christian population in this study show the same positive relationship between Science, Religion and Morality and the omniscient authority dimension of the EBI. This would give a clearer understanding of how religion affects this relationship. Also of interest, would be to investigate the Science, Religion and Morality category of the TSSI-\(v_2\) and the omniscient authority of EBI with this population to see if the same positive relationship is found. This could give a clearer understanding of the definition of omniscient authority. And finally, an investigation of the relationship between the omniscient authority and certain knowledge dimensions of the EBI with this group of participants would also be of interest to see if the same negative relationship exists with this Christian group of participants as with the public university group.
Use of a different instrument to measure attitudes towards science with this same population is recommended. There are many different instruments that have been developed and validated to measure different aspects of attitudes towards science (Kennedy, Quinn, & Taylor, 2016). Specifically used to measure attitudes towards teaching science, is the Dimensions of Attitude towards Science questionnaire (DAS), developed by van Aalderen-Smeets and Walma van der Molen (2013). Use of the DAS could more specifically help to inform teacher education programs.

Within this particular faith-based university, it would be of interest to test different populations of students as to how their epistemological beliefs affect their attitudes towards science, particularly in the area of omniscient authority and certain knowledge. Fulmer (2014) said that he would expect religiosity to be negatively related to omniscient authority and certain knowledge. That was not indicated in this study; but it would be interesting to examine if this was true of theology majors with the same fundamentalist Christian beliefs.
REFERENCES


Odom, L., & Bell, C. V. (2015). Associations of middle school student science achievement and attitudes about science with student-reported frequency of teacher lecture demonstrations


Permission to use the Thinking About Science Survey Instrument

From: Renae Bullock  
Sent: Monday, March 13, 2017 11:32 AM  
To: William W Cobern  
Subject: Permission to use Thinking about Science Survey Instrument

Good morning, Dr. Cobern.

My name is Renae Bullock. I am a doctoral student in Liberty University's EdD Leadership program. My dissertation is on how epistemological beliefs are related to the way in which preservice elementary educators think about science and to their attitudes towards teaching science. I would like to use your Thinking about Science Survey Instrument as part of my study.

This is to request permission to use the Instrument. Thank you.

Renae Bullock

Mar 13 at 1:21 PM

Certainly! Best wishes, bc

Dr. Bill Cobern, Director  
The George G. Mallinson Institute for Science Education  
University Distinguished Professor of Biological Sciences and Science Education  
College of Arts & Sciences  
Western Michigan University
Permission to use Schraw et al.'s Epistemological Beliefs Inventory

Good afternoon, Dr. Bendixen,

My name is Renae Bullock. I am pursuing an EdD in leadership from Liberty University. I am seeking to research the relationship between epistemological beliefs and attitudes towards science of elementary education majors. This email is to request permission to use Schraw’s Epistemological Beliefs Inventory.

Thank you.

Lisa Bendixen
Fri 11/10/2017, 1:13 PMBullock, Renae Reimer
Inbox

Hi Renae,

Yes, you have permission to use the EBI. Best of luck with your research!

Sincerely,

Lisa
Permission to use Measuring Christian Fundamentalist Belief instrument

Good afternoon Dr. Francis.

My name is Renae Bullock. I am working on a dissertation project for my EdD at Liberty University. My research is on the relationship between the epistemological beliefs of pre-service elementary educators and their attitudes towards science. As part of this research, I would like to look into the religiosity of the students that I am surveying from Liberty University. Your survey was recommended to me by Dr. William Cobern.

This email is to request permission to use your questionnaire. The version that I am looking at is the one found in:

Thank you for your consideration.

Renae Bullock

Dear Renae

I am pleased to give my permission for you to use the questionnaire as specified with all good wishes

Leslie

--------------------------------------------------------------------------------------------------------------------------
The Revd Canon Professor Leslie J. Francis
Professor of Religions and Education
Centre for Education Studies
Social Sciences (Room B1.32)
University of Warwick
Coventry CV4 7AL
UK
APPENDIX B

Informed Consent Form

Spring 2018

Dear Elementary Education Major:

This email is to invite you to participate in a study about the relationship between knowledge (epistemological) beliefs and attitudes towards science. I hope in this study to learn more about the factors that contribute to positive attitudes towards science. In particular, completion of this research project will benefit the educational community by increasing understanding of the relationship between epistemological beliefs and attitudes towards science. You are selected as a possible participant in this study because of your elementary education undergraduate major. You are in a group of approximately 100 undergraduates potentially participating in this study.

If you decide to participate, you will proceed by opening the link below in this email message. You will then follow a set of direction within the link that will guide you through completion of three questionnaires. The Thinking About Science Survey Instrument (TSSI) assesses valuation of science as it is commonly portrayed. The TSSI has 42 questions and will take about 10 minutes to complete. An example item is: “Science is the best source of reliable knowledge”. The Epistemological Beliefs Inventory (EBI) assess beliefs of knowledge. The EBI is 28 questions and will take approximately 10 minutes to complete. An example item is: “What is true today will be true tomorrow”. The Christian Fundamentalist Beliefs questionnaire (CBF) assesses a person’s Christian belief. The CBF has a total of 12 questions and will take approximately 3 minutes to complete. An example item is “I believe Jesus died to save me”. The total time investment will be approximately 30 minutes.

Participation in this study is voluntary. There are no anticipated discomforts or risks associated with the study. The questionnaire is entirely anonymous. If you would like, results of this study may be provided to you at your request. Your decision whether or not to participate will not affect your future relations with Liberty University or your school classes. If you agree to participate in this study, you are free to withdraw from the study at any time without penalty. Completion and submission of both surveys will result in your name being entered into a drawing for one of five $25 Starbucks gift certificates.

If you have any questions about this research, you can contact Renae Bullock, rrbullock@liberty.edu, 434-592-4663, or Dr. Rebecca Lunde, Dissertation Chair, rmfitch@liberty.edu. If you have any questions pertaining to your rights as research subject, or about research-related injury, you can contact the International Review Board at Liberty University, Lynchburg, VA 24515, irb@liberty.edu, (434) 592-5530.

To participate in this study, please open the link contained in this email and follow the directions within the link. By opening the link, you signify that you have read the information provided above and have voluntarily decided to participate. [link]

Thank you for your participation.
Renae Bullock
APPENDIX C

Instruments

The Thinking About Science Survey Instrument – Version 2 (TSSI-v2)

This instrument was removed due to copyright.
The *Epistemological Beliefs Inventory*

This instrument was removed due to copyright.
The Christian fundamentalist belief questionnaire

This instrument was removed due to copyright.
APPENDIX D

Demographic Survey

Demographic Data to be filled out before beginning the questionnaires.

Gender: Male Female

Age: 18 19 20 21 22 23

Grade: Freshman Sophomore Junior Senior

Ethnicity: Hispanic/Hispanic American Asian/Asian American African American White American Native American

Religious Affiliation: Christian Muslims Jews non-Religious Other
APPENDIX E

IRB Exemption Letter

April 20, 2018

Renae Reimer Bullock

IRB Exemption 3231.042018: The Relationship Between Epistemological Beliefs and Attitudes Towards Science of Undergraduate Elementary Education Majors

Dear Renae Reimer Bullock,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46.101(b):

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu. Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School

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