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Preservice Teachers' Epistemological Beliefs: A Study of Student and Course Characteristics

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PRESERVICE TEACHERS' EPISTEMOLOGICAL BELIEFS:

A STUDY OF STUDENT AND COURSE CHARACTERISTICS

by

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ABSTRACT

PRESERVICE TEACHERS' EPISTEMOLOGICAL BELIEFS:
A STUDY OF STUDENT AND COURSE CHARACTERISTICS

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The research project described herein was designed to measure teacher education students' epistemological beliefs. Teacher education students' epistemological beliefs were compared according to participants' academic and demographic characteristics as well as characteristics of the courses in which students are enrolled at the time of study data collection. Participants included teacher education students currently studying in Old Dominion University's Darden College of Education. Results indicated that, while participants' epistemological beliefs and the development thereof are both, at times, related to their demographic and academic characteristics as well as the characteristics of the courses in which they were enrolled during the study, sometimes as statistically significant levels, further research needs to be conducted in order to further characterize the nature of these relationships, taking into consideration variables not accounted for in the current study.

This dissertation is dedicated to the memories of my late grandfathers,

Mr. William Thomas Baker (Papa) and Mr. Richard Edward Beck (Dickie).

Though you are no longer here, your spirits inspire me to be a better man.

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

Statement of the Problem

The study described herein was designed to address some of the questions regarding teacher education students' epistemological beliefs, the ways in which these beliefs are tempered by students' individual demographic and academic characteristics, and the impacts that some instructional strategies have on students' epistemological beliefs. Specifically, participating students' epistemological beliefs were compared according to gender, ethnicity, age, their prior academic achievement, the content area in which they plan to teach, the delivery methodology and content of the course(s) in which these students were enrolled at the time of data collection, and the instructional strategies employed by the professors of these courses designed to aid in the development of students' epistemological beliefs.

Background of the Problem

Epistemological beliefs, in general, can be understood as an individual's beliefs about the nature, construction, and evaluation of knowledge (Hofer & Pintrich, 1997). According to Schommer-Aikens (2004), epistemological beliefs are thought to include the following five discrete, independent dimensions: Organization of Knowledge, Certainty of Knowledge, Source of Knowledge, Control of Knowledge, and Speed of Knowledge. Students' beliefs in each of these dimensions have important bearings on their learning orientations and behaviors (e.g., Schoenfeld, 1983; 1985; 1988; Schommer, 1993a).

Schoenfeld (1988) found that the students willing to spend more time on difficult mathematics problems held more sophisticated epistemological beliefs (specifically, beliefs about control of knowledge) than those students who spent less time solving mathematics problems. Similarly, Schommer (1993a) found that students' beliefs about the control of knowledge were strongly correlated with students' high school grade point averages, where students with sophisticated epistemological beliefs earned higher grade point averages.

Need for the Study

It is hoped that the new knowledge resulting from this study will enable teacher educators to better understand and meet their students' learning needs. This aim is particularly important in the teacher education arena, as the students in this context will one day be teachers, themselves. As Hofer and Pintrich (1997) note, "We also need to know more about the intersection of teachers' epistemological theories and those of students" (p. 124). In order to produce more effective teachers, it is not sufficient to identify the nature of pre-service teachers' epistemological beliefs. That is, it is more important to understand how pre-service teachers experience changes in terms of epistemological beliefs than to simply identify the nature of these beliefs. Earlier studies suggested that it is important to consider pre-service teachers' beliefs, particularly epistemological beliefs, in teacher education since such beliefs will influence their performance in the classroom as both teachers and students (Lawrence, 1992; Pajares, 1992; Renne, 1992; Richardson, Anders, Tidwell, & Lloyd, 1991; Shaver, 1992; Wilson, 1990).

Schommer (1994) notes, "The issue of what influences epistemological beliefs is murky at best" (p. 314). The lack of clear research findings indicating the degree to which different factors influence epistemological beliefs is an important consideration, one that will be described thoroughly in this study's review of literature. Hofer and Pintrich (1997) agree that identifying the specific elements of instruction that impact students' epistemological beliefs is "essential" (p. 124). Perry's seminal epistemological beliefs study (1968) and many studies conducted by his successors (e.g., Kardash & Howell, 2000; Kitchener & King, 1981) all indicate a strong relationship between college education and students' development of sophisticated epistemological beliefs. Finally, as Brownlee (2004) notes, teacher education does not often highlight student epistemological beliefs—let alone strategies that may be employed to foster students' epistemological development. As such, it is appropriate to conduct studies such as that proposed here that provide scholars in this field with information about teaching strategies that facilitate (at best) and hinder (at worst) students' development (Schommer, 1990).

Summary

The sections above are designed to familiarize the reader with the current study, one designed to compare teacher education students' epistemological beliefs according to several types of grouping variables—student demographic characteristics, student academic characteristics, and characteristics of the courses in which students were enrolled during the study's data collection. Epistemological beliefs, or one's beliefs about the nature, construction and evaluation of knowledge (Hofer & Pintrich, 1997),

play important roles in one's learning behaviors and academic achievement (e.g., Schoenfeld, 1983; 1985; 1988; Schommer, 1993a).

Understanding students' epistemological beliefs and the factors that impact these beliefs is particularly important in the context of teacher education. These prospective teachers will one day be responsible for encouraging the development of sophisticated epistemological beliefs within students of their own—a task rendered exceedingly difficult for those teachers who do not possess such sophisticated beliefs themselves (Bolden & Newton, 2008). As the process of identifying factors that influence one's epistemological beliefs has left researchers with a "murky at best" understanding of this important issue (Schommer, 1994, p. 314), conducting studies like that described here in the context of teacher education is doubly useful, providing teacher educators with the information and tools they need to better prepare the next generation of K12 teachers.

CHAPTER TWO

LITERATURE REVIEW

The breadth of the current study's scope requires the review of literature on several, widely varied topics. These broad topics include epistemological beliefs, course delivery methodologies, and teacher education student characteristics. These topics are all addressed in detail below.

Epistemological Beliefs

Personal epistemology may be understood as one's beliefs about the nature of knowledge and knowing (Stahl, Pieschl, & Bromme, 2006). Hofer articulates this construct's meaning differently, regarding epistemological beliefs as "beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides, and how knowing occurs" (2002, p. 4). Personal epistemology is known by many other names in the literature. Among them are epistemological beliefs/theories (e.g., Schraw, Bendixen, & Dunkle, 1995; 1998), ways of knowing (e.g., Belenky, Clinchy, Goldberger, & Tarule, 1986), epistemological standards (e.g., Ryan, 1984) and epistemic cognition (e.g., Hofer, 2002). These terms will be utilized in the following review when appropriate with reference to scholarly preference.

The study of epistemological beliefs has occurred in philosophical discourse for centuries. Ancient Greek philosophers such as Socrates and Plato, medieval philosophers like Saint Augustine, and early modern philosophers including Descartes, Locke, and Kant have all explored several issues central to our current epistemological inquiry regarding the nature, sources and limits of human knowledge (Muir, Bendixen, & Haerle, 2006). As no definitive answer to these issues has been brought forth over the years, the

questions persist and are the subject of much modern philosophical as well as educational inquiry.

It is among the primary tasks of every educator to understand the ways in which their students differ in approaches to knowledge and learning (Interstate New Teacher Assessment and Support Consortium, 2001). Part of this understanding depends on teachers' knowledge of epistemology and epistemological beliefs, in general. Simply understanding that different students hold different beliefs about the nature of knowledge and how knowledge may be acquired and evaluated is a requisite condition in order for teachers to create environments conducive to all students' learning (Bondy, Ross, Adams, Nowak, Brownell, Hoppey, Kuhel, McCallum, & Stafford, 2007; Wilkinson & Migotsky, 1992).

Epistemological beliefs are thought to be important to students' learning processes in many ways. Schommer (1994) notes that, while epistemological beliefs "innervate almost every aspect of individuals' day-to-day lives" (p. 293), these beliefs are often ignored in educational research. Compounding this problem is the fact that, among those educational research studies that do investigate personal epistemology, this complex topic is cast in "different shades of meaning from study to study" (Schommer, 1994, p. 294).

It is generally accepted that, while engaged in tertiary education, students' epistemological beliefs progress from naïve to sophisticated as they are confronted with multiple perspectives and are forced to recognize the tentative, uncertain nature of knowledge (e.g., Perry, 1968; Kitchener & King, 1981). While many scholars assert that one's epistemological beliefs naturally increase in sophistication with age (e.g., Kitchener

& King, 1981), it is worth mentioning here that most studies rely on samples made up of college students who are actively engaged in the education process (e.g., Perry, 1970; Baxter Magolda, 1994) rendering it more likely for these students' beliefs to become more sophisticated. Hofer and Pintrich (1997) note that little study has sought to determine if the same progression from naïve to sophisticated holds true with the general public not currently participating in education. Likewise, Hofer (2005) notes that few studies have sought to explore the epistemological beliefs of individuals younger than college age.

The naïve/sophisticated continuum. Scholars interested in the study of personal epistemological beliefs (e.g., Kienhues et al., 2008) have characterized individuals' epistemological beliefs as appearing on continua ranging from naïve to sophisticated. Individuals with naïve epistemological beliefs tend to believe that knowledge is certain and stable, whereas individuals whose epistemological beliefs are characterized as sophisticated believe that knowledge changes over time and can be developed over time, with focused efforts.

Many epistemological beliefs researchers have taken on the task of describing the theoretical levels through which individuals' epistemological beliefs progress as they increase in sophistication. Among the first to characterize this epistemological progression was Perry (1968), who arrived at his model after studying the beliefs of Harvard undergraduates. Perry's model was comprised of nine positions ranging from views of knowledge as absolute and handed down from authorities to views of knowledge as relativistic, and finally, to an acceptance that, while knowledge is

relativistic, commitments should be made to particular points of view, but that these commitments are subject to change throughout an individual's life.

King and Kitchener (1981) described the progression from naïve to sophisticated according to a model they call the Reflective Judgment (RJ) model. This seven-stage model focuses on individuals' abilities to negotiate ambiguous problems. In the earliest stage, individuals believe that knowledge is absolute and handed down from authorities. In the model's fourth stage, individuals believe that, since knowledge is uncertain, evaluating particular perspectives' truth is impossible. In the model's final stage, knowledge is viewed as subjective approximations of reality tempered by an individual's inquiry. King & Kitchener (2002) note that repeated studies on their RJ model indicate that the construct of reflective judgment is related to but not the same as other constructs within the intellectual domain such as academic aptitude and critical thinking.

Epistemological beliefs scholars Belenky, Clinchy, Goldberger, & Tarule (1986) noted that Perry's seminal work, though useful, overlooked women's perspectives. Goldberger (1996) elaborates, noting that though Perry's work failed to address women's development, his model was, at the time of Belenky and colleagues' study, "the only template for understanding shifts over time in an individual's assumptions about the nature of truth, knowledge, and the learning process..." (p. 3). Hofer and Pintrich (1997) echo this sentiment, stating that Perry's (1970) exclusion of 22 of his sample's 24 females from his results was based on an unclear rationale. To address this issue, Belenky and colleagues incorporated Gilligan's (1982) work on women's moral development. Gilligan asserted that women's morality developed according to a three-stage model in which the first stage was characterized by women's desire to please others (conventional

morality). In Gilligan's second stage, women worked to help others (authentic good), and in the final stage, women worked to help others while helping themselves (responsible caring). Based on Gilligan's and Perry's work, Belenky and colleagues developed a five-position epistemological model that incorporates the self alongside discussions of authority and knowledge. While these scholars did not apply their model exclusively to women, they did note that the model would accurately depict more women than men. In the first position of epistemological development, individuals were silent, passive recipients of knowledge from authorities. In the second position, individuals regard themselves as able to reproduce objective knowledge handed down from authorities, but were unable to generate new knowledge themselves. In the third position, knowledge is viewed as being personal and resulting from intuition. The fourth position is characterized by a view that knowledge can be obtained and transmitted through objective procedures, while at the final position, knowledge is both gained and communicated through both objective and subjective means.

Learning-centered epistemological research. McDevitt (1990) found that undergraduate college students' epistemological beliefs influenced the frequency with which they asked their professors questions about course content. In similar studies focused on historical knowledge, Fournier and Wineburg (1993) arrived at similar findings. Namely, students with naïve epistemological beliefs learned history by passively accepting "facts" handed down from authorities. This sort of learning behavior is connected to poor student performance.

Dweck & Bempechat (1983) and Dweck & Leggett (1988) studied the degree to which students will persist when engaged in a difficult learning task. These scholars

focused primarily on students' perceived control over the learning process—that is, whether students believed their ability to learn was fixed or that they could improve their learning capacity. Students who adopted the perspective that they can improve their learning capacity were found to be more willing to persevere in difficult learning tasks, while those who adopted the perspective that their learning capacity was fixed became frustrated and cease their efforts. Those who continued trying to accomplish difficult learning tasks performed better than those who gave up.

Schoenfeld (1983, 1985, 1988) extended this line of inquiry into students' mathematics learning. Similarly, Schoenfeld found that the students willing to spend more time on difficult mathematics problems held more sophisticated epistemological beliefs (specifically, beliefs about control of knowledge) than those students who spent less time solving mathematics problems. Finally, Schommer (1993a) found that students' beliefs about the control of knowledge were strongly correlated with students' high school grade point averages. Students with sophisticated beliefs about their control of knowledge acquisition had higher grade point averages, while students who possessed naïve beliefs in this epistemological dimension had relatively low grade point averages. Michael Ryan (1984a) studied students' epistemological beliefs as they relate to reading comprehension. Specifically, Ryan found that students with naïve beliefs in the certainty dimension of epistemological beliefs felt that they understood a textual passage so long as they could remember definitions and basic facts therein. In contrast, students with sophisticated beliefs about the certainty of knowledge believed that they understood texts only when they could apply facts from the texts to new situations. Schommer (1990) strengthened the link between student epistemological beliefs and reading

comprehension. She found that students with naïve beliefs about their control of knowledge acquisition demonstrated less comprehension of text passages. Similarly, students with naïve beliefs about the certainty of knowledge performed more poorly on comprehension measures than did their epistemologically sophisticated counterparts. Additionally, theorists such as Spiro, Coulson, Feltovich, and Anderson (1988) have found that students' perspectives on the source and certainty of knowledge factor into the ways in which these students deal with ill-defined, complex problems.

Linearity of the progression from naïve to sophisticated? Perry (1968) did not feel that students progressed from one position on his epistemological framework to another in a uniform, linear fashion. Rather, he believed that students could slow down the process of epistemological development or even revert back to positions that had previously been outmoded.

King, Kitchener, Davison, Parker, & Wood (1983) regarded the progression from naïve to sophisticated epistemological beliefs as linear; that is, once an individual completed a particular stage of these scholars' Reflective Judgment (RJ) model, that stage was never revisited. King, Kitchener, Wood, & Davidson (1989) evaluated three groups of students—high school juniors, college-level juniors and doctoral students during a six-year longitudinal study, noting that only through longitudinal data can assertions be safely made with regard to individuals' progressions through the stages of the RJ model (as cited in King & Kitchener, 2002). They found a substantial positive correlation between age and epistemological development, lending strong support to the notion that students progress through epistemological stages in a relatively linear, sequential fashion. Specifically, King & Kitchener (2002) reported that nearly all their

participants (92%) showed epistemological development during the ten-year study and that beliefs for more than two-thirds of their sample either stayed the same or grew between each testing interval. Likewise, study participants rarely skipped stages. Rather, their progression through each stage of King & Kitchener's RJ model was demonstrated, lending support to the value of this personal epistemology framework. These findings' significance is strengthened by the fact that King & Kitchener's original sample included high school, undergraduate, and graduate students (2002). This feature of their study allows King & Kitchener to assert the linearity of progress through epistemological positions for three different groups of participants, rather than only undergraduate college students (the common participants in epistemological beliefs studies).

While King & Kitchener (2002) do espouse the belief that individuals progress through ordered epistemological beliefs stages in a linear fashion, they caution scholars to avoid characterizing students' epistemological beliefs as firmly contained within one or another stage, as this is rarely the case. In fact, participants in King & Kitchener's longitudinal study frequently expressed beliefs of multiple stages at once. These scholars' data analysis procedures allowed them to characterize the stage which most often governed a participant's beliefs and actions as that participant's dominant stage. Since Belenky and colleagues' (1986) work was not longitudinal, they stopped short of claiming that their model was developmental—that is, that the model depicted positions through which individuals progressed in a linear fashion.

Schommer (1990) likewise proposed that one's beliefs within any one of these dimensions need not reflect his beliefs in the other epistemological dimensions. Stated

differently, it is possible for the same individual to hold sophisticated beliefs in one or more dimensions while holding naïve beliefs in other dimensions.

Epistemological belief dimensions. Schommer (1990) arrived at the multidimensional approach to epistemological beliefs based on her reactions to the earlier works of Perry (1968; 1970), Kitchener and colleagues (1981; 1983), Belenky and colleagues (1986), and Ryan (1984). She regarded their unidimensional approaches to personal epistemology as overly general and likely unable to effectively characterize the numerous links between epistemological beliefs and learning. In addition to providing a more detailed picture of one's epistemological beliefs, Schommer's multidimensional epistemological model allowed her to compare individuals with different combinations of epistemological beliefs in terms of these combinations' effects on learning processes. Schommer hypothesized that epistemological beliefs can be separated into five separate dimensions (source of knowledge, certainty of knowledge, structure of knowledge, speed of learning, and stability of knowledge).

Schommer's source of knowledge dimension dealt with a continuum of beliefs that ranged between the idea that knowledge can come only from omniscient authorities to the idea that knowledge can be identified through both objective and subjective processes. Her certainty of knowledge dimension dealt with a hypothesized continuum of ideas ranging between the notion that knowledge is absolute to the idea that knowledge is constantly evolving. The structure of knowledge dimension deals with the range of beliefs between knowledge being compartmentalized and simple to the idea that knowledge is inherently interconnected and complex. Schommer's speed of learning dimension is concerned with the beliefs that range from the perspective that individuals

will either learn something quickly or not at all to the beliefs that, given enough effort, any individual is capable of learning. Finally, her stability of knowledge dimension deals with the range of beliefs between the idea that people are born with inherent intellectual ability to the idea that one's intellectual ability can be developed over time. See Table 1 for another explanation of Schommer's five hypothesized dimensions.

Table 1

Schommer's Five Hypothesized Epistemological Beliefs Dimensions

Dimension	Explanation	
	Naïve	Sophisticated
Source of Knowledge	Knowledge can come only from omniscient authorities.	Knowledge can be identified through both objective and subjective processes.
Certainty of Knowledge	Knowledge is absolute and timeless.	Knowledge is constantly evolving.
Structure of Knowledge	Knowledge is compartmentalized and simple.	Knowledge is inherently interconnected and complex.
Speed of Learning	Individuals will either learn something quickly or not at all.	Given enough effort, any individual is capable of learning.
Stability of Knowledge	People are born with inherent intellectual	One's intellectual ability can be developed over

	ability.	time.

Schommer's (1990) claim that epistemological beliefs are multidimensional was reinforced by Jehng, Johnson, & Anderson (1993), who were able to reproduce four of Schommer's five hypothesized epistemological beliefs dimensions in their study of college students from Illinois. This study's findings are useful, given the large, diverse nature of their sample.

Piagetian influences. As with many areas of educational inquiry, Piaget figures prominently into the discussion of personal epistemology. His term, "genetic epistemology" (Piaget, 1950) was used to describe intellectual development and is thought to have spurred on educational researchers interested in this intersection between philosophy (the traditional realm of epistemology) and psychology (the traditional realm of intellectual development) (Hofer & Pintrich, 1997). Piaget's development scheme (1950) also served as inspiration for Perry's (1970) position-based epistemological development model in which individuals were believed to undergo experiences that generated cognitive disequilibrium. This disequilibrium would then lead to assimilation and/or accommodation of new beliefs. As many epistemological development models are based on Perry's model, the importance of Piaget's influence should not be minimized.

Similarly, Piaget's findings related to individuals' cognitive abilities (e.g., argumentation in Kuhn, Amsel, & O'Laughlin, 1988) at the concrete operational development stage (Inhelder & Piaget, 1958) are consistent with epistemological development as measured by Kuhn and colleagues (1988). That said, the correlation

between epistemological beliefs and Piagetian development is not a perfect one. King (1977) implemented the Reflective Judgment Interview to several groups of students alongside a measure designed to indicate whether participants had achieved Piaget's formal operational development stage and found that, while most participants had achieved the formal operational level, their epistemological beliefs were not uniformly sophisticated.

Finally, critics of epistemological beliefs inquiry subject the field to the same sort of criticism faced by Piaget's development theories. Specifically, both schools of thought are subject to criticism based on the notion that both fields' models presuppose endpoints (formal operational development [Piaget, 1958] and sophisticated epistemological beliefs [e.g., Perry, 1970; Schommer, 1994]) that are only appropriate in a Western context. Hofer and Pintrich (1997) suggest that overcoming this criticism should be among the chief goals of researchers interested in the study of epistemological beliefs development.

The value of sophisticated epistemological beliefs. Though it is well understood at this point that epistemological beliefs tend to progress from naïve to sophisticated, it is thus far unclear why sophisticated epistemological beliefs are preferred to naïve epistemological beliefs. In other words, is encouraging the rapid, thorough development of epistemological belief sophistication worth an educator's time and effort? If so, what benefits come along with sophisticated epistemological beliefs?

Sophisticated epistemological beliefs and learning strategies. Mason & Boscolo (2004) found that students who possessed sophisticated epistemological beliefs were better able to recognize, compare, reason through and judge competing ideas on a particular topic (in this instance, transgenic food) than were their counterparts with naïve

epistemological beliefs. Sinatra, Southerland, McConaughy, & Demastes (2003) arrived at similar findings when using a different topic—evolution. In their study, students with more sophisticated epistemological beliefs were more likely to accept the validity of human evolution than were their less sophisticated counterparts.

In other closely related studies, Schommer (1990; 1993) found that students with sophisticated epistemological beliefs had higher GPAs than their counterparts with more naïve epistemological beliefs.

Stathopoulou & Vosniadou (2007) conducted a series of studies in which they compared students with sophisticated epistemological beliefs to those with naïve epistemological beliefs in terms of their understanding of basic physics concepts. These scholars found that, while sophisticated epistemological beliefs are not the only prerequisite for physics understanding, students with sophisticated epistemological beliefs demonstrated much higher physics understanding than did their naïve counterparts.

Dweck and Leggett (1988) also assert that possessing sophisticated epistemological beliefs can assist students in goal-setting. Similarly, Hofer (1994) assessed two different calculus instructional environments and found that students in the environment designed to foster students' development of sophisticated epistemological beliefs set goals and demonstrated self-efficacy and self-regulation more effectively than did students in the environment not designed to foster epistemological development. In addition, Hofer found that the students in the environment designed to encourage epistemological growth achieved at higher levels than did their counterparts in the other context.

Cultural considerations. Another issue that arises in the discussion of the objective values associated with sophisticated epistemological beliefs is cultural. Specifically, do the values associated with sophisticated epistemological beliefs transcend cultural differences? Hofer and Pintrich (1997) worry, "The common developmental endpoint of most of the models of epistemological development may be a socially constructed artifact of Western schooling and culture" (p. 121).

Goldberger (1996) notes that valuable knowledge is defined in vastly different ways between cultures. She cites "collectivist" cultures in which experts (usually elders) are respected and authority is not questioned. Clearly, sophisticated epistemological beliefs are not desirable in such contexts. As Jehng, Johnson, and Anderson (1993) note, "In general, though, we suppose that the acquisition of epistemological beliefs is a process of enculturation: students learn to view knowledge from the same perspective as those around them..." (p. 25).

Sophisticated epistemological beliefs and teachers. Once it has been established that, at least in Western societies, sophisticated epistemological beliefs come along with objectively valuable outcomes, it then becomes necessary to determine how teachers may encourage their students' epistemological development. Beers (1984) expressed her belief that teaching should explicitly include epistemological discussions. Schommer (1990) echoes this sentiment, suggesting that, as early as grade school, teachers begin sensitizing their students to the integrative nature of knowledge and to the fact that multiple "right" answers often exist. In order for teachers first to recognize the need to incorporate epistemological issues into their instruction and second to effectively guide their students toward the development of more sophisticated epistemological beliefs,

teachers must possess sophisticated epistemological beliefs, themselves (Brownlee, 2004). Brownlee stated that teachers with naïve epistemological orientations are more likely to view knowledge as absolute and categorical. These teachers' instruction would follow accordingly, encouraging students to passively receive absolute truth from the authority (in this case, the teacher). Teachers with sophisticated epistemological beliefs, on the other hand, are thought to be more likely to "conceive of teaching from a constructivist of transformative perspective" (p. 4). These teachers would encourage their students to actively engage in content and arrive at personal meaning. This discussion makes it clear that, so long as sophisticated epistemological beliefs are valuable for students, such sophisticated beliefs are likewise valuable for teachers, providing them with the means necessary to effectively encourage their students' epistemological development.

Kitchener and King (1981) note that students with naïve epistemological orientations may be unable to effectively understand sophisticated lines of argument. In reflecting on Kitchener & King's point, Schommer (1994) notes that such difficulty may have practical consequences when individuals take on evaluative roles like those of a "juror, parent, or teacher" (p. 297).

Domain specificity of epistemological beliefs. Early epistemological beliefs research was conducted based on the assumption that epistemological beliefs were domain independent; that is, scholars believed that an individual's epistemological beliefs had no relationship to major fields of study and that one's epistemological beliefs in one domain would reflect their epistemological beliefs in all other domains (Muis, Bendixen, & Haerle, 2006). Here, it is appropriate to elaborate on what is meant by the word

"domain." In the context of epistemological beliefs, a domain can be understood as conditional (knowing where and when), procedural (knowing how) and declarative (knowing that) knowledge on a given topic (Paris et al., 1983). Further, domains can be characterized as either more or less academic. Domains like math and psychology are more academic, while the domains of chess or swimming are less academic (Glaser et al., 1987). Though not all lines between various academic domains are clear and objective, epistemological beliefs researchers (e.g., Jehng, Johnson, & Anderson, 1993; Schoenfeld, 1985) often compare students majoring in hard science fields like physics, mathematics or chemistry with other students majoring in soft sciences (e.g., sociology) or liberal arts. While the general consensus in the field of epistemological beliefs used to hold that one's beliefs were domain independent, emerging scholarship indicates that epistemological beliefs may be domain specific (e.g., Jehng et al., 1993). Jehng and colleagues compared the epistemological beliefs of university students majoring in four distinct fields– Arts/Humanities, Social Science, Engineering, and Business. Based on the nature of these fields, Jehng and colleagues formed two groups—hard fields (Engineering and Business) and soft fields (Arts/Humanities and Social Science). These scholars identified differences in these groups' participants' epistemological beliefs in several of Schommer's (1990) hypothesized epistemological beliefs dimensions—Certainty of Knowledge, Omniscient Authority, and Orderly Process (analogous to Schommer's Speed of Learning dimension). These findings support the notion that participants with specialties in different academic disciplines or domains may well possess different epistemological beliefs.

Paulsen and Wells (1998) samples students majoring in different fields of study and sorted these students according to Biglan's (1973) taxonomy. In this taxonomy, Biglan identifies fields on continua that range from hard to soft and from pure to applied. Fields at the hard end of the former continuum feature an increased level of "paradigmatic development" than those at the soft end (Paulsen & Wells, 1998, p. 371). Such hard fields included natural sciences and engineering, while social sciences, education, humanities, fine arts, and business were classified as soft. The pure-applied continuum deals with the degree to which each field emphasizes applying practical problems. Pure fields in the Paulsen & Wells study included humanities, fine arts, and both social and natural sciences, while applied fields included education, business, and engineering. Through this categorization, Paulsen & Wells were able to position each of the aforementioned disciplines along both of Biglan's continua. When students' epistemological beliefs were measured, results indicated that students in Biglan's pure fields are more likely to possess sophisticated beliefs in several epistemological beliefs dimensions than their applied-field counterparts. Likewise, students in Biglan's soft fields were more likely to possess sophisticated epistemological beliefs than their hard-field counterparts. The nature of the differences between the fields studied by Paulsen & Wells is debatable and continues to be the subject of inquiry, but what is clear is that there were measurable differences between the epistemological beliefs of students participating in the study of these different fields. These findings lend further support to the notion of the domain specificity of at least some epistemological beliefs.

Many scholars (e.g., Bromme, Kienhues, & Stahl, 2008; Buehl, Alexander & Murphy, 2002; Muis, Bendixen, & Haerle, 2006) now assume that individuals possess

two sorts of epistemological beliefs—some that are domain-general (transcending particular contexts) and others that are domain-specific (Kienhues, et al., 2008). This assumption is lent credence by the somewhat contradictory findings produced by several studies (e.g., Jehng et al., 1993; Schommer, 1993; Schommer & Walker, 1995) that have examined students' epistemological beliefs across different fields of study. Alexander and Judy (1988) note that both domain-specific and domain-independent knowledge are necessary in order for one to experience successful learning and problem solving.

While several studies (e.g., Jehng et al., 1993) have demonstrated that individuals with different fields of study (hard sciences vs. soft sciences/liberal arts, in the case of Jehng, et al.) possess measurably different epistemological beliefs, no study has addressed the question of whether or not these beliefs persist when individuals are positioned within different contexts beyond their major fields of study.

King & Kitchener (2002) suggest the possibility that sophisticated epistemological beliefs may first be fostered in academic domains that individuals pursue in depth and then may be generalized, over time, to other domains with which individuals are not so deeply engaged.

Education level and epistemological beliefs. Jehng and colleagues (1993) found that graduate students possessed statistically significantly more sophisticated epistemological beliefs than did their undergraduate counterparts, but while junior- and senior-level undergraduates possessed slightly more sophisticated epistemological beliefs than did their under-class counterparts, this difference was not statistically significant. Nevertheless, Jehng and colleagues' findings do support the notion that an individual's

epistemological beliefs may become more sophisticated as they are exposed to post-secondary education.

A meta-analytic review conducted by King & Kitchener (2002) supports the notion that epistemological beliefs increase as individuals participate in education. These scholars identified five studies that implemented the RJI with high school student participants and found that the average participant in these studies demonstrated pre-reflective thinking indicative of less sophisticated epistemological beliefs. By contrast, traditionally aged college undergraduate students participating in 20 similar studies demonstrated slightly more sophisticated thinking indicative of more sophisticated epistemological beliefs. While the statistical difference between high school and undergraduate college students was small, the typical undergraduate student participant acknowledged uncertainty—a key marker along the continuum of epistemological sophistication. Finally, among seven studies whose participants were graduate college students, the average participant demonstrated reflective thinking that approached the high end of the RJ model. The highest levels were achieved only by those students who were engaged in doctoral-level study.

Measuring epistemological beliefs. Hofer and Pintrich (1997) note that identifying the specific components of instruction that influence students' epistemological beliefs is essential and that such identification could be facilitated by ethnographic and observation-based studies. These scholars believe that such approaches could allow for easier study of instructional components not regularly included in other epistemological beliefs studies—out of class tasks, evaluation and assessment practices, classroom structure and physical layout, and textbook contents and structure.

Quantitative, self-report instruments. The three most popular epistemological beliefs measures (described below) were developed between 1990 and 2002 (Schommer, 1990; Schraw, Bendixen, & Dunkle, 2002; Wood & Kardash, 2002), prior to wide acceptance of the notion that epistemological beliefs were context- or discipline-specific (e.g., Hofer, 2000; Schommer & Walker, 1995)—that is, that one may espouse certain epistemological beliefs in the context of physics and other epistemological beliefs in the context of reading comprehension (for instance) (DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008). Schommer (1990), Schraw and colleagues (2002), and Wood & Kardash (2002) governed their work based on the assumption that epistemological beliefs were related but that these beliefs could develop according to different trajectories. Still, these beliefs were thought to develop independently of specific domains/contexts (DeBacker et al., 2008).

Because of the ease of use and convenience associated with self-report survey instruments like those described in the following sections, these instruments' use dominates the contemporary epistemological beliefs literature. Nevertheless, DeBacker and colleagues (2008) have identified problems associated with the use of these instruments. These problems are psychometric/quantitative and theoretical in nature and will be discussed in detail in the following sections.

Epistemological Questionnaire. The Epistemological Questionnaire (EQ) was developed and implemented by Schommer beginning in 1990. Schommer developed the instrument by creating two or more subsets (totaling 12) of items (totaling 63) to measure participants' positions within her five hypothesized epistemological belief dimension—structure of knowledge, certainty of knowledge, source of knowledge, nature of ability,

and speed of learning. In her primary study using the new instrument, Schommer (1990) was able to demonstrate the presence of factors aligned with four of the five hypothesized dimensions. She was unable to demonstrate the presence of a source of knowledge factor.

Though studies using the EQ have been numerous and varied (e.g., Clarebout, Elen, Luyten, & Bamps, 2001; Kardash & Howell, 2000; Paulsen & Wells, 1998), it bears noting that scoring procedures render these studies' findings suspect. Findings from the EQ are analyzed according to factor analyses of subset scores derived directly from each participating sample. To illustrate this point, DeBacker and colleagues wrote, "Because scoring of the instrument is typically based on a factor analysis of subset scores in each new sample, individual studies may in essence be using different instruments" (p. 284). In other words, as different samples of students may report beliefs that load into different sets of factors, the EQ renders comparisons between samples problematic.
To further complicate matters regarding the EQ, some studies (e.g., Schommer, Crouse, & Rhodes, 1992; Schommer, 1993; Schommer, Calvert, Gariglietti, & Bajaj, 1997) did arrive at three- or four-factor models similar to those identified in Schommer's original study (1990), but they did so based on organizations of different item subsets than those used in Schommer's original study. Similarly, other scholars (Schommer-Aikins, Duell, and Barker, 2002) arrived at four-factor models like those present in Schommer's original study, but these researchers provided no explanation of the means through which they identified these factors.

The EQ has been translated into at least one other language—Dutch—as part of Clarebout and colleagues' 2001 study. Likewise, the instrument has been shortened for use in other studies (e.g., Schommer, 1993).

Quantitative/psychometric problems with the EQ have been identified in numerous reviews of the instrument including that by DeBacker and colleagues (2008). These scholars cited problems such as low internal consistency of belief scales observed in some individual studies. Observed internal consistency coefficients have ranges from as high as .63 to .85 in Schommer's (1993) study to as low as .51 to .78 in Schommer-Aikins and colleagues' (2002) study. DeBacker and colleagues (2008) attribute these low internal consistency scores to researchers' inability to replicate results across studies.

Epistemological Beliefs Inventory. Schraw and colleagues (2002) developed the Epistemological Beliefs Inventory (EBI) based on Schommer's (1990) five hypothesized epistemological belief dimensions. Schraw and colleagues developed new items that they felt better encapsulated Schommer's dimensions, hoping their efforts would result in a self-report instrument that would prove more valid and reliable than Schommer's EQ. They believed that their original items would allow for the identification not only of the four factors Schommer observed in her original study (1990), but of the fifth factor (source of knowledge) that Schommer hypothesized but which the data never indicated.

Initial studies that utilized shorter, preliminary versions of the EBI produced promising results (Bendixen, Schraw, & Dunkle, 1998; Schraw et al., 2002). Both studies' findings indicated the presence of all five of the hypothesized factors, but internal consistency coefficients remained low--.67-.87 for Bendixen and colleagues and .58-.68 for Schraw and colleagues. Subsequent studies, on the other hand, did not yield

the expected five factors (e.g., Nussbaum & Bendixen, 2002; 2003). As scoring the EBI as directed by Schraw and colleagues (2002) does not involve factor analysis, most other studies report only internal consistency data (e.g., Ravindran, Greene, & DeBacker, 2005; Hardré, Crowson, Ly, & Xie, 2007) including ranges of .54-.78 for Ravindran and colleagues' study and .42-.79 for Hardre et al.'s study.

Epistemological Beliefs Survey. Kardash & Wood (2002) reported that they had been unable to reproduce Schommer's (1990) five expected factors in numerous studies which employed either the EQ or an epistemology measure developed by Jehng, Johnson, & Anderson (1993) which tapped the same constructs that appear in Schommer's EQ using some of Schommer's (1990) original items and some originals. As such, Kardash and Wood integrated the two instruments and arrived at an 80-item survey called the Epistemological Beliefs Survey (EBS) that they hoped would allow them to confirm each of Schommer's hypothesized dimensions. After repeated internal consistency testing and preliminary factor analyses, Kardash and Wood retained only 38 items that they claimed loaded onto five factors—two that seem analogous to Schommer's Speed of Learning and Structure of Knowledge dimensions, and three that were novel including Knowledge Construction and Modification, Characteristics of Successful Students, and Attainability of Objective Truth. Though few studies have employed the EBS, Sinatra & Kardash (2004) and Schommer-Aikins & Easter (2006) did conduct studies with the instrument and reported alpha values for the instrument's constructs ranging from .54 to .74.

Qualitative approaches. Much of the early epistemological beliefs research utilized qualitative interviews as their primary data collection instruments. Among others, Perry (1968; 1970) conducted interviews with undergraduates from Harvard

University in order to eventually arrive at his nine-position epistemological beliefs model.

Many of the early interview-based epistemological beliefs studies (e.g., Perry, 1970) employed largely open-ended interview questions. As Hofer and Pintrich (1997) note, such an approach is appropriate for initial studies into nearly any field of interest. Later scholars (e.g., Belenky et al., 1986) included both open-ended and more focused items within their interview protocols.

Baxter Magolda's research (e.g., 2004) is also qualitative in nature and will be featured again prominently in the section below on Longitudinal Studies. Baxter Magolda has conducted several qualitative studies of individuals' epistemological beliefs. Her approach has changed over the years, as has the nature of the qualitative measures she uses to collect data from her participants. Particularly, in her earliest studies, Baxter Magolda employed semi-structured interviews, but in later studies, she moved toward an informal, conversational style of interview (2004). This approach allowed participants to structure the interviews, themselves, while Baxter Magolda focused on asking follow-up questions that allowed participants to elaborate on points they had brought up themselves.

Reflective Judgment Interview. Among the most common qualitative instruments used within epistemological beliefs inquiry is the Reflective Judgment Interview (RJI). This interview is described by King and Kitchener (1994; 2002) as an hour-long "semi-structured discussion of four ill-structured problems" (2002, p. 43). Trained interviewers begin with standard probing questions and then follow-up with questions designed to elicit focused, clear responses from participants. Responses are then transcribed and

evaluated with reference to one or more of the components of the Reflective Judgment (RJ) model described earlier in this review.

Challenges associated with qualitative measures. As Hofer and Pintrich (1997) point out, measuring epistemological beliefs is not an easy task. Interview-based epistemological beliefs inquiry, due to its nature, has limited replicability. The costs associated with interview-based inquiry, in terms of data collection and analysis, are generally too great to allow for large sample sizes. Likewise, the most widely used interview protocol—the Reflective Judgment Interview (King & Kitchener, 1994)—requires researchers to be trained and certified in the instrument's use.

An additional challenge associated with interview-based epistemological beliefs measures deals with the structure of the interview. Some interview questions (for instance, those included in instruments employed by Kuhn [1991] and King & Kitchener [1994]) prompt respondents to provide evidence to justify a particular point of view. While such questions are appropriate, given that these questions focus on the domain of interest, they do introduce the risk that, in forcing respondents into the evidence/justification framework, they fail to tap into domains that are "more personally salient dimensions" (Hofer & Pintrich, 1997, p. 130). In other words, interview questions that force participants into frameworks designed by the instrument's author may not hone in on other areas where more fruitful epistemological beliefs data would present itself.

Domain-specific instruments. In 2007, Stathopoulou & Vosniadou studied the epistemological beliefs of Greek, high school-aged physics students using the Greek Epistemological Beliefs Evaluation Instrument for Physics (GEBEP). This instrument

included items designed to assess epistemological beliefs in only two of Schommer's (1994) hypothesized dimensions—the nature of knowledge and the process of knowing.

Longitudinal studies. Among those scholars who have adopted a longitudinal approach to measurement of epistemological beliefs, Perry (1968; 1970) and Baxter Magolda (e.g., 1993; 1994) are the most notable. In his seminal work in personal epistemology, Perry interviewed Harvard undergraduates in an attempt to evaluate the changes in their beliefs he believed correlated with progression through collegiate study. Perry's interview protocol and participant selection procedures are described elsewhere in this review, but his study spanned four years and laid the foundation upon which many subsequent scholars based their longitudinal designs. Baxter Magolda (2004) expanded on Perry's work, conducting a longitudinal study that spanned 16 years and tracked participants' epistemological development between the ages of 18 and 34 years. Like Perry's, Baxter Magolda's procedures and protocol descriptions are included elsewhere in this review.

Additional researchers have implemented longitudinal studies designed to measure participants' epistemological beliefs, as well. Using their Reflective Judgment Model (a model based in large part on Perry's work), King and Kitchener (1981, 1994), along with other colleagues (1983, 1989) have conducted longitudinal studies with college students.

Factors influencing epistemological beliefs. Schommer (1994) notes that while epistemological beliefs are widely regarded as products of home as well as formal education experiences, the nature and extent of the influences imparted by these factors and their respective components remains largely unexplored. Baxter Magolda (2004)

echoes Schommer's sentiment stating, "Beliefs about self, learning, classroom instruction, and domain-specific beliefs are part of personal epistemology" (p. 31). As Bendixen and Rule (2004) note, "Most would agree that epistemological beliefs develop and change over time. A consensus on how and when these changes take place is another matter" (p. 70). The classroom-based factors that lead to students' epistemological growth (described below in the Instructional Strategies section of this review) are relatively well-understood and thoroughly represented in the epistemological beliefs literature.

Aside from instructional strategies, however, it is noteworthy that students' fields of study have been found to impact students' epistemological beliefs in some important ways. Much less is known regarding the links between epistemological beliefs and variables like students' culture that impact students outside the classroom.

Outside the classroom influencing factors. Pai (1990) regards the dominant American educative process as conflicting with cultural elements common among non-white subcultures within the American education system. Specifically, Pai's findings indicate that American schools' focus on learning for the sake of individual achievement is at odds with the collectivist approach to learning—that is, the notion that the goal of learning is group achievement—held by many Asian American, Hispanic American, African American and Native American families. Along these same lines, Pai argues that the American educational model emphasizes personal involvement and active engagement, but that students raised in the collectivist approach focus on passive learning characterized by silent listening and emulation.

In a study of adults' epistemological beliefs, Schommer (1993b) sampled adults of varying walks of life and educational experiences (ranging from high school to graduate school). Schommer found that age, level of educational attainment and home life each predicted participants' epistemological beliefs.

Gender. Brabeck and Larned (1996) suggest that the study of gender differences in epistemological beliefs should be framed around several important questions. First, are there differences in men's and women's ways of knowing? Second, what accounts for these differences? Finally, and most importantly, what are the implications and impacts of these differences on individuals' education, occupations, and social processes? King and Kitchener (2002) echo this sentiment, challenging researchers to engage in gender comparisons in varied samples and across contexts.

King and Kitchener (1994) discussed 14 studies that have compared men to women with regard to their RJI scores. In half the studies in which such comparison was made, no gender differences were identified. Additionally, in one study where gender differences were identified, these differences were attributed to differences in participants' educational level, since male participants in this study were much more likely to have earned an advanced degree than were their female counterparts.

Wood (1993) reported that growth in epistemological beliefs (as measured by King and Kitchener's RJI) occurred in spurts and that, while females experiences a large epistemological "growth spurt" during their late teen years, males experienced an analogous spurt several years later, while engaged in collegiate study.

Ethnicity.

One of the more problematic issues that have confronted epistemological beliefs researchers is ethnicity (or race, largely in earlier studies) and the role that this demographic factor plays in epistemological beliefs development. Schommer (1994) notes that, while there is almost certainly a link between culture and epistemological beliefs, the connection between epistemological beliefs and their causes is "murky at best" (p. 314).

Course Delivery Methodologies

The US Department of Education (2009) conducted a rigorous meta-analysis including studies that compared online to face to face instruction. These scholars found that, in general, students in online learning environments achieved better learning outcomes than did students in face to face learning environments. Jaggers and Bailey (2010) conducted a similar meta-analysis but included only those studies that focused on fully-online, semester-long college courses. Their results did not support the earlier reports by the US DOE (2009) that online learning produces better learning outcomes. Instead, the Jaggers and Bailey (2010) study found that online courses produced neither strong advantages nor disadvantages for participating students. While two of the studies reviewed in their meta-analysis indicated increased course achievement for the online students, the remaining five indicated either mixed results or decreased course achievement when online students were compared to their face-to-face counterparts. Neither of the studies mentioned above dealt with student epistemological beliefs and the ways these are impacted by course delivery methodologies. Kelly, Ponton, & Rovai (2007) noted that, while the impacts of different course delivery methodologies remain largely unexplored, it is important to begin systematic analysis of the pedagogy at work

in higher education instruction so that findings related to learning outcomes can be better understood.

Changing Epistemological Beliefs

In this review, it has been sufficiently demonstrated that sophisticated epistemological beliefs are desirable for a number of important reasons. As such, it seems reasonable to predict that studies geared toward identifying and developing strategies designed to positively impact students' epistemological beliefs would be numerous. After a thorough review of the literature, this prediction is not accurate. As Kienhues and colleagues (2008) note, while outcry for such studies exists (e.g., De Corte, Op't Eynde, & Verschaffel, 2002; Kardash & Scholes, 1996; Schraw, 2001), only a few studies have explored this area of epistemological beliefs inquiry (e.g., Brownlee, 2003; Conley, Pintrich, Vekiri, & Harrison, 2004; Gill, Ashton, & Algina, 2004; Valanides & Angeli, 2005). The following sections will review some of the more fruitful areas of research related to this issue.

Epistemic doubt. Epistemic doubt is thought by some (e.g., Bendixen & Rule, 2004) to be the touchstone for the development of more sophisticated epistemological beliefs. Epistemic doubt can be understood as an individual's experience of doubt regarding their epistemological beliefs. While Boyes & Chandler (1992) believe that epistemic doubt and resultant change only occur once an individual has achieved a relativistic level of epistemological beliefs (i.e., beliefs that knowledge is too complex to be characterized as simply right or wrong), Bendixen & Rule (2004) regard epistemic doubt as a process that can occur within individuals at any epistemological belief level. Regardless of when individuals are most likely to be affected by epistemic doubt, Dole

and Sinatra (1998) lend credence to the assumption that epistemic doubt is an important ingredient in the epistemological change process, claiming that in order for change to occur, new information must be (among other things) plausible. Bendixen and Rule (2004) explain that, while an individual experiences epistemic doubt, they weigh evidence, determining what is plausible and what is not. This weighing of evidence can (but does not necessarily) result in an individual's adoption of more sophisticated epistemological beliefs. While too few studies have evaluated epistemic doubt in detail, Bendixen (2002) conducted a retrospective, qualitative study on the model. Findings from this study support the notion that epistemic doubt plays an important role in the development of sophisticated epistemological beliefs.

One component of Brownlee's (2004) explanation of Baxter Magolda's (1993) relational pedagogy approach to development of sophisticated epistemological beliefs bears a striking resemblance to epistemic doubt. In relational pedagogy, teachers implicitly and explicitly encourage their students to reflect on their epistemological beliefs, presumably hoping that this reflection will result in epistemic doubt and epistemological development within the students. While relational pedagogy is more thoroughly described elsewhere in this review, it is important to note here that Brownlee's (2004) study of relational pedagogy indicated that this strategy's use did result in epistemological development within participating students. Also important is the fact that the relational pedagogy approach highlights the teacher's role in structuring a learning environment that fosters epistemic doubt.

Epistemic volition. It is believed by some (e.g., Bendixen & Rule, 2004) that Epistemic Doubt, on its own, is not sufficient to change an individual's epistemological

beliefs. These scholars believe the Epistemic Volition must also be present. Epistemic Volition can be understood as the metacognitive process by which individuals control their focus and effort in the face of internal and external distractions. Such volition is important in this discussion epistemological beliefs because, in practical terms, epistemic volition is the process undertaken by those who "take ownership" of their epistemological beliefs. In this sense, without epistemic volition, epistemic doubt is moot. However, once an individual passes through the epistemic doubt and volition stages, that individual may still regress if that individual lacks resolution strategies requiring that individual to act according to new epistemological beliefs. Resolution strategies can only be enacted once an individual has advanced through episodes of Epistemic Doubt and Volition.

Necessary conditions for conceptual change. Bendixen & Rule (2004) assert that their model for epistemological change only occurs when one (or both) of two conditions is satisfied. The first of these conditions is dissonance, and the second is personal relevance. Dissonance is regarded by King and Kitchener (1994) as a condition in which one's experience does not match their expectation. This dissonance sets the stage for epistemic doubt—the direct questioning of epistemological beliefs during dissonant experiences. It is important also to note the possibility that dissonance may not always result in the development of more sophisticated epistemological beliefs. In fact, dissonance may result in no change or backward change (regression).

Aside from dissonance, it is also possible that personal relevance may set the stage for epistemological change. Personal relevance, in this context, may be understood as the condition in which an individual has a stake in an outcome, is personally interested in a topic, or feels high self-efficacy regarding epistemological change.

The use of refutational texts in content instruction has been shown to provide the necessary conditions for conceptual change to occur (Allen, 1991; Guzzetti, Snider, & Gamas, 1993). The use of refutational texts is described later in this review, but it is important to note here that insomuch as refutational texts can allow for epistemic doubt and eventually conceptual change, this strategy's use fits well into Bendixen & Rule's (2004) system of epistemological change. Likewise, the fact that refutational texts can be used in numerous disciplines reflects the strategy's contextual flexibility.

Instructional Strategies

King & Kitchener (2002) note the importance of exploring specific features of individuals' educational experiences (curricular and pedagogical) and connecting these to trends in epistemological beliefs development. They regard such practices as necessary steps in scholars' attempts to provide individuals with optimal educational experiences. Hofer and Pintrich (1997) agree, regarding the process of identifying instructional strategies that encourage the development of students' epistemological beliefs as "essential" (p. 38).

Before highlighting some of the strategies that have been shown to produce favorable results in terms of facilitating students' epistemological development, it is important to take note of the status quo—that is, the standard instructional trends at work in today's education system. Shoenfeld (1988) and Rigden & Tobias (1991) conducted studies indicating that much instruction at the K12 and undergraduate college levels implicitly discourages students' epistemological development. In both studies, high school and college-level instructors were asked to compare two types of instruction. In both cases, instruction that focused on students' acquisition of particulate, objective facts

was preferred over instruction focused on reasoning or elaboration. Bolden and Newton (2008) note that, due to the ever-increasing amount of content teachers are required to disseminate and the standardized assessments that are so pervasive in today's K12 education, instruction that focuses on coverage rather than understanding is often required. Such instruction is at odds with the encouragement of students' epistemological development.

In contrast, Beers (1988) found that some instructors implicitly encouraged their students to develop sophisticated epistemological beliefs by downplaying the importance of facts and encouraging students toward thorough understanding. Schommer (1994) adds that educators should encourage students to view education as the means through which they can construct knowledge for themselves rather than passively accepting knowledge handed down by others. Schommer went on to recommend that teachers encourage their students to regard difficult learning tasks as challenges rather than failures. Encouraging students to thoughtfully explore and seek multiple solutions to complex problems was suggested as a means to this end (Langer, 1993).

In a seminal epistemological beliefs study, Perry's (1968) participants (Harvard undergraduates) reported believing that their instructors used specific techniques to encourage students to arrive at answers on their own rather than blindly accepting wisdom handed down from instructors. These sorts of instructional techniques are of particular interest, because the frequency of use and the effectiveness of such techniques implicitly impede or encourage the students' development of sophisticated epistemological beliefs.

Since epistemological beliefs develop gradually over time, it may be tempting to regard instruction geared toward students' epistemological beliefs as futile; however, Gill and colleagues (2004) found that, while generalized (domain- or context-independent) epistemological beliefs may be resistant to change when presented with short term epistemological development interventions, other domain-specific epistemological beliefs can change as a result of short-term interventions (Kienhues et al., 2008).

Brownlee (2004) notes that teacher education often fails to focus on student epistemological beliefs—let alone strategies that teachers may use to influence their students' epistemological beliefs. She believes that teacher education should help pre- and in-service teachers reflect on their pedagogy and the ways in which their instructional strategies impact students' epistemological beliefs. Boden and colleagues (2005-2006) agree, asserting that curriculum should be developed to intentionally help students progress toward epistemological sophistication. Specifically, Brownlee (2004) advocates the development of instructional strategies that help students connect curricular content to their own beliefs about knowing and knowledge. Boden and colleagues elaborate, advocating the instructional use of case studies, role playing, interviews, collaborative efforts with peers, and opportunities for self-reflection. Several such instructional strategies will be described in the following paragraphs of this review.

Relational pedagogy/connected teaching. Relational Pedagogy or Connected Teaching is an instructional approach in which students are encouraged to include their own experiences to validate their beliefs about curricular content. Also involved in Relational Pedagogy is the notion that "an atmosphere of care and trust" (Brownlee,

2004, p. 5) is prerequisite in order for Relational Pedagogy to provide opportunities for students' epistemological beliefs to develop.

More specifically, Relational Pedagogy includes three elements—"mutual respect, situating learning in students' experiences, and facilitating a constructivist perspective of knowing and learning" (Brownlee, 2004, p. 5). Mutual respect involves both cognitive and emotional support between learners and instructors geared toward empathic and respectful approaches to students' experiences. Situating learning in students' experiences can be accomplished in many ways, but Brownlee (2004) required that students write journal entries linking theoretical issues from the curriculum to students' lived experiences. Using students' experiences as evidence/validation for their beliefs regarding theoretical issues is a common means used to assist students in the construction of knowledge, and as Brownlee (2004) notes, this too can be accomplished through journaling.

Relational Pedagogy, as described by Baxter Magolda (1993b), is important not simply because it involves students' experiences, but because this instructional practice requires that students compare their own beliefs (developed in response to their experiences) to beliefs of experts. Baxter Magolda argues that such inter-relationship between self and theory represents sophisticated epistemological beliefs on many of the most prevalent epistemological beliefs development models, such as those by Perry (1970), Belenky and colleagues (1986), and Baxter Magolda (1993a).

It is possible that, while Relational Pedagogy may work well in some instructional contexts (such as educational psychology, as was the case in Brownlee's 2004 study), this instructional approach may be more difficult to facilitate in other contexts such as studies

of the hard sciences that may less readily lend itself toward discussions of students' own experiences.

Brownlee (2004), in her year-long study of Australian Teacher Education students, found that in a relational pedagogy-driven learning environment, students' epistemological beliefs did progress from more naïve to more sophisticated. The relational pedagogy at work in Brownlee's (2004) study required students to participate in reflective journal writing. During the journal writing process, students were prompted to explicitly explore their own epistemological beliefs.

It must be noted, however, that studies that measured the development of students' epistemological beliefs over time (e.g., Brownlee, 2004) are limited in one particular way—they are unable to isolate the agents that accounted for the epistemological development among their participants. While these studies go to great lengths to describe the teaching methods at work in at least one particular learning environment, none detailed each of the learning contexts to which participants were exposed. This limitation is reasonable, given the impracticality of describing each course in which each participant was enrolled—not to mention the non-academic experiences that may have impacted students' epistemological beliefs.

Refutational epistemological instruction. Refutational Epistemological Instruction represents a different approach to encouraging epistemological beliefs development among students. While Relational Pedagogy involves encouraging students to compare their own experiences and beliefs with those beliefs held by experts, Refutational Epistemological Instruction involves the presentation to students of texts which include intuitive, popular assumptions that are then refuted with alternative

scientific theories (Kienhues, et al., 2008). It is believed by many that these two-sided refutational texts create a condition of cognitive dissonance within the minds of learners, leading eventually to learners' dissatisfaction with their previously held assumptions. In retaining its alignment with thorough conceptual change (described elsewhere in this review), refutational texts also include new knowledge that the learners must then integrate with their prior knowledge. The use of refutational texts has been studied in several meta-analytic studies (e.g, Allen, 1991) in which these texts' use has been found promote conceptual change. Because of tentative connections between conceptual change and epistemological belief development asserted by Bendixen and Rule (2004), some now believe that the use of refutational texts may also encourage students' development of sophisticated epistemological beliefs. Similar studies that have employed discussions of controversial issues have already demonstrated that such discussions can result in epistemological beliefs development among students (e.g., Kuhn, 1991; Mason & Boscolo, 2004).

It is also worth noting that, while Brownlee (2004) regarded Relational Pedagogy as an instructional method poorly suited to science education contexts, Kienhues and colleagues conducted their 2008 study of Refutational Epistemological Instruction in a science context, demonstrating the somewhat intuitive probability that there is no one instructional method best suited for encouraging students' development of sophisticated epistemological beliefs in all educational contexts. In their study, Kienhues and colleagues modeled their design after that employed in conceptual change studies that involved the use of refutational texts (Diakidoy, Kendeou, & Ioannides, 2003; Salisbury-Glennon & Stevens, 1999). Kienhues and colleagues compared the epistemological

beliefs of two groups of students—one of which was instructed with a straight-forward, informational instructional method, and the other of which received instruction including refutational texts. These scholars' findings are described later in the study and point to the absence of a clear connection between conceptual change and epistemological beliefs development.

Writing instruction. Beers (1984) suggested that certain types of writing instruction may aid in students' development of sophisticated epistemological beliefs, though she noted, "I am quite sure that no prescription for such an endeavor can be written at this time" (p. 12). Even over the tentative backdrop of her claim, Beers did identify several conditions that must be satisfied in order to writing instruction to effectively influence students' epistemological development. First, students must be at least partially conscious of their epistemological beliefs. Next, students must be willing to modify their current beliefs about knowledge. Finally, Beers believes that students must be able to conceive of alternatives to their current beliefs about knowledge.

Unexpected shifts and findings. In their study involving the epistemological beliefs of German university students in a Genetics course, Kienhues and colleagues (2008) implemented two different types of instruction—informational and refutational (see 'Refutational Epistemological Instruction') in order to determine if refutational instruction would result in the development of more sophisticated epistemological beliefs among participating students. Surprisingly, these scholars found that while refutational instruction resulted in the development of more sophisticated epistemological beliefs among those students who began the study with naïve epistemological beliefs, this sort of

instruction resulted in the regression of epistemological beliefs (becoming more naïve) among those students who began the study with sophisticated epistemological beliefs. Nussbaum and Bendixen (2003) conducted a study in which they correlated undergraduate students' epistemological beliefs to their tendencies to avoid or approach argument. Participating in argumentative discourse has been found to improve student learning outcomes in science (Alexopoulou & Driver, 1996; Chinn, O'Donnell, & Jinks, 2000) and writing (Reznitskaya, Anderson, McNurlen, Nguyen-Jahiel, Archodidou, & Kim, 2001). Based on the emerging relationships between sophisticated epistemological beliefs and desirable learning outcomes, it was hypothesized that students with more sophisticated epistemological beliefs would be more willing than their epistemologically naïve counterparts to approach argument. Findings indicated just the opposite relationship. Students with sophisticated epistemological beliefs were found to be more likely to avoid argument than their epistemologically naïve counterparts.

Teacher Education Student Characteristics

Among the literature on teacher education student characteristics, there are no recent studies that do an ample job at describing these students' demographic identities; nor are there studies that describe these students' epistemological beliefs. While scholars like Haberman (1995) and Harris & Sass (2007) agree that teachers' individual characteristics have a powerful bearing on their students' learning and that some characteristics are more desirable than others, they disagree on just what these desirable characteristics are.

Brownlee's (2004) study measured the development of Australian teacher education students' epistemological beliefs over time, finding that various elements of

teacher education programs can impact students' epistemological in desirable, measurable ways. Specifically, Brownlee (2004) found that, when students were exposed to constructivist teacher education environments that focused explicitly on their epistemological beliefs, these students' epistemological beliefs became more sophisticated.

Instructors' Epistemological Beliefs

Instructors' epistemological beliefs have been found to have numerous significant connections to their professional practice and their students' learning outcomes. As Brownlee and Berthelsen note, "The understanding of teachers' beliefs systems about teaching and learning can be informative about the manner in which their practice is then constructed" (2006, p. 19).

In their meta-analysis of studies that connect instructors' epistemological beliefs to their professional practice, Arrendolo and Rucinski (1996) reported that teachers who possessed sophisticated, relativistic epistemological beliefs behaved in more democratic ways during their teaching (Silver, 1975 as cited in Arrendolo & Rucinski, 1996). Likewise, teachers with sophisticated epistemological beliefs were found to be more empathetic, innovative and able to use more effective teaching strategies than were their counterparts who possessed less sophisticated epistemological beliefs (Miller, 1981 as cited in Arredondo & Rucinski, 1996).

Similarly, Hashweh's 1996 study found that science teachers who possessed sophisticated epistemological beliefs were more likely to value and discuss students' alternative notions surrounding scientific phenomena than were their less epistemologically sophisticated counterparts. Likewise, the epistemologically

sophisticated science teachers could employ more instructional strategies than could their less sophisticated counterparts and were more likely to implement instructional strategies designed to encourage conceptual change among students.

In a related study, White (2000) found that teachers with sophisticated, relativistic epistemological beliefs tended to analyze classroom problems in a complex, multi-faceted way that took into account school and family influences on classroom problems. Alternatively, teachers with less sophisticated epistemological beliefs were found to be more likely to deal with classroom problems in simplistic ways, usually selecting courses of action based on their own personal experiences without taking into consideration other, more complex factors.

Brownlee (2001; 2003) found that teachers who possessed sophisticated epistemological beliefs were more likely to view teaching as a process of facilitating students' acquisition of knowledge, while less epistemologically sophisticated teachers tended to view teaching as a process of knowledge transmission. This finding is particularly salient when viewed in the context of Daniels's and Shumow's (2003) proposal that students educated in facilitative environments demonstrated higher levels of motivation, problem-solving, and language skills and experienced lower levels of stress when compared to students educated in an environment where the focus was placed on transmission of knowledge. In a similar study focused on the relationships between teachers' beliefs and students' learning outcomes, Halloun and Hestenes (1985) noted that students whose beliefs about learning matched those of their instructors demonstrated improved learning outcomes.

Summary

Based on the literature reviewed above, it has been made clear that epistemological beliefs are important factors with relation to both the teaching and learning processes. Students' epistemological beliefs interact meaningfully with the ways in which they engage learning tasks, and teachers' epistemological beliefs inform the ways in which they instruct their students. As such, exploration of teacher education students' epistemological beliefs—a topic that is under-represented in the literature—is worthwhile, as these students will one day be charged with helping in the epistemological development of their own future students. Likewise, as instructors' epistemological beliefs have been found to impact their students' epistemological beliefs (as well as other factors associated with the teacher-student relationship), it is necessary for researchers to continue searching for relationships between instructors' epistemological beliefs and their impacts on students' beliefs, especially in the context of teacher education contexts that, at times, implicitly encourage students to adopt naïve epistemological beliefs.

Next, it is clear that, aside from academic experiences, students' backgrounds may impact their epistemological beliefs in important ways. Factors like gender, ethnicity, cultural background, and age are all believed to have substantial implications with regard to individuals' epistemological beliefs, yet scholars in this field have yet to identify the underlying factors that connect students' characteristics to their beliefs. As such, studies designed to provide a more thorough picture of the interactions between students' characteristics and their epistemological beliefs are desirable. On a related point, students' academic experiences have been found to correlate positively with their epistemological beliefs; that is, as students engage in more and more collegiate study, their epistemological beliefs have been found to become more sophisticated. That said,

none of the studies that address this issue employed teacher education student samples. As such, it remains to be seen whether this trend (i.e., more collegiate study yields more sophisticated epistemological beliefs) will be borne out among students engaged in teacher education course work.

Furthermore, it is clear that different instructional techniques interact with students' epistemological beliefs in important ways, sometimes leading students toward more sophisticated beliefs and sometimes leading students toward more naïve beliefs. Like the relationship between student characteristics and epistemological beliefs, the specific ways in which different instructional strategies impact students' beliefs has been under-explored in this field's scholarship, so studies geared toward addressing this issue are needed. Similarly, while online, distance learning courses are becoming increasingly ubiquitous, no studies have sought to determine whether different course delivery methodologies differentially impact students' epistemological beliefs.

Based on all these general findings, a study has been conducted to address several of what the researcher believes to be the most important gaps in epistemological beliefs research. The research questions and hypotheses according to which this study was conducted are included next.

Research Questions

The current study will seek answers to the following central research questions:

1. What is the relationship between teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics?

2. What is the relationship between the development of teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics?

3. What is the relationship between the development of teacher education students' epistemological beliefs and the characteristics (course delivery methodology, epistemological beliefs-oriented instructional strategies employed by the professors, and professors' epistemological beliefs) of the classes in which they are enrolled during the study?

Hypotheses

Because of the mixed nature of the findings throughout the epistemological beliefs literature, null hypotheses to the study's guiding research questions (above) were adopted. The inquiry sought to identify deviations from the null hypotheses listed below.

1. There is no relationship between teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics.

2. There is no relationship between the development of teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics.

3. There is no relationship between teacher education students' epistemological beliefs and the characteristics (course delivery methodology and epistemological beliefs-

oriented instructional strategies employed by the professors) of the classes in which they are enrolled during the study.

CHAPTER THREE

METHODS

Research Design

The proposed study employed a mixed-methodological, comparative design. Such a design is appropriate, as the researcher sought to determine whether statistically significant differences existed between the epistemological beliefs of the subgroups of participating students derived from the independent/predictor variables described above. These predictor variables included demographic and academic variables. Additionally, analyses designed to allow the researcher to make inferences about the relationship between the development of participating students' epistemological beliefs and their demographic and academic characteristics as well as features of the courses in which participating students were enrolled at the time of the proposed study's implementation were conducted. In order to access this information, various data sources, sampling strategy, and data collection instruments are described below.

Data Sources and Participants

Study data were gathered from course instructors and students within Old Dominion University's Darden College of Education. The student participants' characteristics are described in detail in Tables 2 – 3 below. In order to address this study's first research question, the researcher analyzed data from all those participating students who completed the SCEBS (Table 2). A different group of students, including some who completed the SCEBS and some who did not, completed the SCEBS-2. Only those students who completed both the SCEBS and the SCEBS-2 (Table 3) were included in analyses dealing with this study's second and third research questions.

Table 2

SCEBS Participants' Characteristics

Variable	Level	Number	Percent
Age	19 years or younger	6	3.0
	20-24	73	36.7
	25-29	33	16.6
	30-34	26	13.1
	35-39	20	10.1
	40-44	14	7.0
	45 years or older	27	13.6
Ethnicity	African American	27	13.6
	Asian/Pac. Islander	7	3.5
	Caucasian	147	73.9
	Hispanic	11	5.5
	Native American	2	1.0
	Other	4	2.0
	Missing	1	.5
Gender	Female	166	83.4
	Male	32	16.1
	Missing	1	.5
Education	High School	7	3.5
	2 Yrs. Undergrad.	89	44.7
	Bachelor's	75	37.7

	Master's	28	14.1
Prospective Teaching Grade Level	Early Childhood	7	3.5
	Elementary	78	39.2
	Secondary	75	37.7
	Other	14	7.0
	Not Teaching	25	12.6
Prospective Teaching Content Area	English	30	15.1
	Foreign Languages	4	2.0
	Math	23	11.6
	Arts	10	5.0
	PE/Health	4	2.0
	Sciences	15	7.5
	Social Studies	13	6.5
	Special Ed.	38	19.1
	Other	37	18.6
	Not Teaching	25	12.6

Table 3

SCEBS and SCEBS-2 Participants' Characteristics

Variable	Level	Number	Percent
Age	19 years or younger	3	3.0
	20-24	30	29.7
	25-29	17	16.8

	30-34	17	16.8
	35-39	13	12.9
	40-44	7	6.9
	45 years or older	14	13.9
Ethnicity	African American	8	7.9
	Asian/Pac. Islander	3	3.0
	Caucasian	81	80.2
	Hispanic	5	5.0
	Native American	1	1.0
	Other	2	2.0
Gender	Female	85	84.2
	Male	15	14.9
	Missing	1	1.0
Education	High School	3	3.0
	2 Yrs. Undergrad.	44	43.6
	Bachelor's	38	37.6
	Master's	16	15.8
Prospective Teaching Grade Level	Early Childhood	4	4.0
	Elementary	37	36.6
	Secondary	33	32.7
	Other	12	11.9
	Not Teaching	15	14.9
Prospective	English	13	12.9

Teaching Content Area	Foreign Languages	2	2.0
	Math	13	12.9
	Arts	6	5.9
	Sciences	6	5.9
	Social Studies	7	6.9
	Special Ed.	18	17.8
	Other	21	20.8
	Not Teaching	15	14.9

Instructor data were gathered through the implementation of surveys including both closed-ended, quantitative and open-ended, qualitative items. Student data were gathered through the implementation of surveys including closed-ended, quantitative items and one open-ended, qualitative item. All surveys are described at length in the Instruments section below.

Sampling Strategy

In order to identify participants for the proposed study, course instructors and students within the Darden College of Education were identified through convenience sampling. As all courses within the College's teacher education programs are pertinent to the purpose of this study, convenience sampling was a reasonable approach to identification of participants, and since the proposed study's data analysis plan requires a substantial sample size, convenience sampling was an appropriate approach.

All students enrolled in each of the participating courses were invited to participate in the proposed study; however, some students chose to refuse participation without any

penalty. When invited to participate, students were made aware of the study's intent and general procedures, including those designed to protect participants' anonymity and the confidentiality of study data and informed of their rights as research participants.

Instruments

The primary instrument employed during the proposed study was the Epistemological Beliefs Inventory (EBI) (Schraw, G., Bendixen, L. D., & Dunkle, M. E., 2002). Schraw and colleagues (2002) set out to develop an instrument which would prove a valid and reliable measure of each of Schommer's (1995) five hypothesized epistemological dimensions. To realize this goal, Schraw set out to develop an instrument whose items clearly fit into one or another subscale. While the Epistemological Questionnaire (EQ) (Schommer, 1995) included more than 60 items, the EBI includes only 28 or 32 Likert-type items (depending on version). The 32-item version was employed during the study described here, for it was the version through which the presence of Schommer's five dimensions were most clearly identified. When evaluating the EBI, Schraw and colleagues (2002) identified five solid factors with reliability values of between .58 and .68. As was the case with the EQ, however, subsequent studies by Nussbaum and Bendixen (2002, 2003) did not identify the same five-factor model. Still, Schommer's five hypothesized dimensions are still regarded as likely in much of the literature, so adopting an instrument associated with these dimensions was logical, in keeping with the current state of this field's scholarship. Strengths of the EBI include its utility and improved internal consistency scores compared to the EQ, while weaknesses include the fact that the EBI has been employed

most often in studies with small samples, rendering the findings subject to scrutiny. See Appendix A for a copy of the EBI.

In addition to the EBI, participating students were asked to respond to closed-ended items designed to address their demographic and academic characteristics as well as the courses in which the students were enrolled at the time of the study's implementation and the course delivery methodologies through which these courses were administered. These items, along with the EBI, constitute a survey called the "Student Characteristics and Epistemological Beliefs Survey" (SCEBS; Appendix B).

Similarly, a second student survey called the "Student Characteristics and Epistemological Beliefs Survey – Part Two" (SCEBS-2; Appendix C) was implemented. This survey included one open-ended, qualitative item asking students to reflect on their experiences in the course(s) they identified in the first survey—specifically, the strategies (if any) they perceived were used by their instructors to foster students' epistemological beliefs. In addition to this qualitative item, SCEBS-2 included all items on the EBI. While the EBI's validity and reliability have been evaluated numerous times, the SCEBS and SCEBS-2 measures were developed by the researcher for use in the proposed study and, as such, have not yet been rigorously evaluated for validity and reliability. That said, both instruments were evaluated to ensure their face validity by the researcher's dissertation committee chair and evaluated as necessary prior to the instruments' administration.

Instructor data were collected through an instrument called the "Instructional Strategies and Epistemological Beliefs Survey" (ISEBS; Appendix D) developed by the researcher for use in the proposed study. This instrument contains all 32 items of the EBI

as well as seven closed-ended, quantitative items and two open-ended, qualitative items designed to measure instructors' perceptions of the relationship between epistemological beliefs and student performance, instructors' beliefs about their ability to influence their students' epistemological beliefs, and the strategies they report using in order to impact their students' epistemological beliefs. As with the SCEBS measures, the ISEBS contains all items from the EBI; therefore, this portion of the instrument can be assumed to possess reasonable levels of validity and reliability. However, the open- and closed-ended items developed for use in the proposed study have not been rigorously evaluated for validity or reliability. That said, the ISEBS was evaluated for face validity by the researcher's dissertation committee chair and modified as necessary prior to its implementation.

Procedures

Prior to the beginning of the academic semester during which study data are to be collected, Institutional Review Board exempt status was obtained from the Institutional Review Board housed within Old Dominion University's Darden College of Education. Next, participating instructors were identified. In order to identify instructors willing to participate in the study, a letter of invitation was sent via email to each potential participating instructor. See Appendix E for a copy of this letter of invitation.

Following the identification of participating instructors and their provision of student rosters, the researcher contacted each potentially participating student via email with a letter invitation, including informed consent material and instructions for participation in the SCEBS instrument. See Appendix F for a copy of this letter of invitation. Students implied their willingness to participate by completing the SCEBS

instrument. If questions or concerns arose, students were instructed to contact the researcher, and their questions and/or concerns were addressed accordingly. Students were given approximately two weeks to complete the SCEBS instrument.

Near the end of the semester during which study data were collected, participating students as well as those students who did not participate in the SCEBS instrument but who are enrolled in courses that participating instructors are teaching were contacted via email again, this time inviting them to participate in the SCEBS-2 instrument. See Appendix G for a copy of this second letter of invitation. At around the same time as the second letter of invitation was sent to participating students, a letter was sent to participating instructors asking them to participate in the ISEBS instrument. See Appendix F for a copy of this letter to participating instructors. Instructors and students were given approximately two weeks to complete either the ISEBS or the SCEBS-2.

Throughout data collection, extreme care was exercised in order to protect the confidentiality of study-related data. To this end, all study data was either be housed in a password protected server maintained by Old Dominion University or locked securely in a filing cabinet housed in the researcher's office. This office was only accessible when the researcher or his office mates were present. In order to ensure anonymity of participants, both instructors' and students' names were replaced in all study documents by unique identifying numbers assigned by Old Dominion University. Likewise, data provided by students was reported in aggregate, and no individual student was identified—even by their unique identifying number.

Upon completion of study data collection, data were analyzed according to the protocol described later in this Methods section. Once data were analyzed, Results and

Discussions were generated and shortened versions of these findings will subsequently be shared with participating students and instructors.

Data Analysis

In order to analyze all study data, both quantitative and qualitative data analysis techniques were employed. These techniques are described below.

Quantitative data analysis. Descriptive statistics were employed to tabulate students' demographic and academic characteristics. This process allowed for various participant subgroups to be generated—a step necessary in order to conduct subsequent analyses. Next, participating students' responses to the SCEBS and SCEBS-2 items taken from the EBI (Schraw et al., 2002) were organized according to the five hypothesized dimensions of epistemological beliefs that the instrument seeks to assess. See Table 4 for a list of EBI items included within each dimension.

Table 4

EBI Items Associated with the Five Hypothesized Epistemological Belief Dimensions

Dimension	Item Numbers
Source of Knowledge	4, 7, 20, 27, 28
Certainty of Knowledge	2, 6, 14, 19, 22, 23, 25, 31
Organization of Knowledge	1, 10, 11, 13, 18, 24, 30
Control of Learning	5, 8, 12, 15, 17, 26, 32
Speed of Learning	3, 9, 16, 21, 29

Students who report sophisticated beliefs in the source of knowledge dimension are likely to disagree with statements such as, "Parents should teach their children all there is to

know about life," and "When someone in authority tells me what to do, I usually do it," while students with naïve source of knowledge beliefs will likely agree with such statements. In the certainty of knowledge dimension, students with sophisticated beliefs will likely disagree with statements like, "Science is easy to understand because it contains so many facts," and "The moral rules I live by apply to everyone," while students with naïve beliefs will disagree. Within the organization of knowledge dimension, students with sophisticated beliefs in this dimension are likely to disagree with statements like, "Too many theories just complicate things," and "The best ideas are often the most simple," while students with naïve beliefs in this dimension are more likely to agree. Next, in the control of learning dimension, students with sophisticated epistemological beliefs in this dimension will likely disagree with statements like, "People can't do too much about how smart they are," and "How well you do in school depends on how smart you are," while students with naïve beliefs are more likely to agree with such items. Finally, students with sophisticated beliefs within the speed of learning dimension are likely to disagree with statements like, "If a person tries too hard to understand a problem, they will most likely end up being confused," and "If you haven't understood a chapter the first time through, going back over it won't help," while students with naïve beliefs in this dimension will likely agree.

Further, it is important to mention that, while most of the items were coded such that responses on the low end of the Likert-type scale of responses (Disagree and Strongly Disagree) corresponded with sophisticated epistemological beliefs, several of the items were reverse-coded. In these items, responses on the high end of the Likert-type scale (Agree and Strongly Agree) indicated sophisticated epistemological beliefs

(Teo & Chai, 2011). For example, "Absolute moral truth does not exist" is a statement with which disagreement would reflect naïve beliefs, while agreement will reflect sophisticated beliefs. Because of this coding issue, student responses to the reverse-coded items on both the SCEBS and SCEBS-2 instruments were reversed in order for these responses to align with their normally-coded counterparts. Reverse-coded items were as follows: 2, 6, 14, 20, 24, 30, and 31.

In order to address the researcher's first research question, a series of multiple analyses of variance (MANOVAs) were conducted. In each of these MANOVAs, the five dimensions of students' epistemological beliefs measured by the EBI component of the SCEBS served as the dependent variables, and the demographic and academic variables listed above served as the independent/grouping variables. These omnibus MANOVA analyses allowed the researcher to determine whether statistically significant differences existed between any of the subgroups of students' beliefs in any of the five epistemological beliefs dimensions. In the event that statistically significant differences were identified, one-way analyses of variance (ANOVAs) were conducted in order to determine the specific epistemological beliefs dimensions in which statistically significant differences existed. Finally, follow-up post-hoc tests were conducted in order to determine the specific student groups between which statistically significant differences existed. Again, analyses conducted to answer the first research question included all those participants who completed the SCEBS (Table 2).

In order to address this study's second and third research questions that focus on the development of students', multiple analyses of covariance (MANCOVAs) were conducted. In each of these analyses, students' epistemological beliefs as measured by

the SCEBS-2 served as the dependent variables. In analyses designed to address the study's second research question, students' demographic and academic characteristics again served as the independent variables, while in analyses designed to address the study's third research question, the characteristics of the courses in which the participating students were enrolled served as the independent variables.

In each of the MANCOVAs conducted to address the study's second and third research questions, students' epistemological beliefs as measured by the SCEBS served as the covariates. In the MANCOVA procedure, students' epistemological beliefs as assessed by the SCEBS were held constant, and their SCEBS-2 beliefs were adjusted accordingly. In the event that MANCOVA results indicated statistically significant differences between the groups' SCEBS-2 epistemological beliefs after adjusting these beliefs to reflect the adjusted SCEBS beliefs that MANCOVA held constant, it could then be inferred that the groups' epistemological beliefs had developed at different rates during the course of the study, in the context of the participating courses in which they were enrolled. As such, the researcher used these MANCOVA results to make inferences regarding the possibility that different groups of students' epistemological beliefs developed at differential rates throughout the course of the study, in the context of the participating courses in which these students were enrolled.

Qualitative data analysis. Qualitative data were far less numerous that quantitative data, but because effective qualitative data analysis was necessary in order to ensure effective quantitative data analysis via analyses of variance procedures, extreme care was taken to ensure that qualitative data were analyzed rigorously. Qualitative data pertaining to participating instructors' self-reported instructional strategies designed to

impact students' epistemological beliefs were first analyzed from a holistic perspective, in the hopes that general themes would emerge pertaining to instructors' use of strategies designed to influence students' epistemological beliefs. Next, data were separated into units of meaning and carefully coded, according to the theme structure. Once data were coded, conclusions were drawn with regard to each individual participant. Finally, qualitative findings were used to confirm that participating instructors' responses to closed-ended items regarding their epistemological beliefs-oriented instruction were in line with the responses they provided to the open-ended items. In the event that discord existed, the researcher followed up with participating instructors in order to elicit more information about the instructional strategies they brought to bear. Since the researcher chose to report only those instances in which qualitative data conflicted with quantitative data, qualitative data are nearly absent from the Results and Discussion chapters of this document.

Limitations

The limitations that threaten the proposed study's findings can be generally grouped into two categories—internal and external validity threats. These threats will be described in the following section of this Methods section.

Internal validity. The proposed study's findings' internal validity was threatened by a host of factors. Chief among these is the fact that all data collection measures yield self-report data. Such self-report data often entail data biased by social desirability. Participants may tend to answer in dishonest ways because they believe that these dishonest answers may be viewed as more desirable by society at large or, more likely in this context, the researcher himself. Also associated with the self-report nature of the

proposed study's data collection instruments is a testing threat. Essentially, because the instruments are being completed in an unpredictable environment, students may not take the surveys seriously and may provide inaccurate responses to their items. This threat was made more serious because of the repeated testing aspect of SCEBS and SCEBS-2. These two instruments share 32 items (the EBI), and because of this, students may be more apt to either not take the second survey seriously or to provide exactly the same responses to SCEBS-2 as those they provided for SCEBS. It should be noted, though, that were these threats to be mitigated by the researcher, the number of participants able to take part in the study would have declined sharply. Specifically, were the researcher to employ observation-based designs or heavily interview-based designs, though the threats associated with self-report data may be mitigated, the researcher would have been able to collect data from a far smaller group of participants. As such, though these internal validity threats must be taken into account, they are necessary.

External validity. As the population of interest in the current study includes all those teacher education students enrolled in the various teacher preparation programs at one university, it is possible that the study's participants may not accurately represent the larger population. In this case, the study's findings' generalizability may be suspect. It is likewise possible that generalizability may be threatened in terms of time. Perhaps the picture that the proposed study's findings draw is accurate today but, for some unforeseen reason, inaccurate tomorrow. While less likely, this threat is also worth exploring.

In terms of ecological validity, or the extent to which study findings may be reasonably applied to other contexts, the study's findings are limited. As mentioned above, the population of interest in the current study includes teacher education students

studying at one university. Applying this study's findings beyond this context must be considered with extreme caution, given the vast differences between institutions.

CHAPTER FOUR

RESULTS

Introduction

This chapter is devoted to reporting the findings resulting from the analyses described above that were undertaken in order to address the following research questions:

1. What is the relationship between teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics?

2. What is the relationship between the development of teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics?

3. What is the relationship between the development of teacher education students' epistemological beliefs and the characteristics (course delivery methodology, epistemological beliefs-oriented instructional strategies employed by the professors, and professors' epistemological beliefs) of the classes in which they are enrolled during the study?

Each research question will be addressed in its own major section within this chapter. It should be understood that in all parametric analyses outlined below, an alpha level of .05 was adopted, so only significance (p) values that are .05 or smaller indicated statistically significant differences between groups' epistemological beliefs.

Data Set Construction and Sanitation

Prior to relating the current study's findings, it is necessary to describe the process through which important data were integrated into useful data sets. As both qualitative and quantitative data were collected in order to address this study's research questions, and because data were drawn from several data sources—SCEBS and SCEBS-2 for participating students and ISEBS for participating professors—construction of the data set was a complicated process that proved integral to the data analysis process.

Student Beliefs and Demographic and Academic Characteristics

This section includes results related to this study's first research question. The following subsections will relate information pertaining to the relationships that were identified between participating students' epistemological beliefs and their demographic characteristics including their gender, ethnicity, and age as well as the relationships that were identified between students' epistemological beliefs and their academic characteristics including the highest level of education they had achieved and the grade level(s) and content area(s) in which they planned to teach. Since analyses conducted in order to address this research question did not seek to characterize participating students' epistemological beliefs development, all students who completed the SCEBS (pre-test) were included in the analyses described in this section. These participants' epistemological beliefs are summarized below in Table 5 below.

Table 5

Summary of SCEBS Participants' Epistemological Beliefs

Dimension	Minimum	Maximum	Mean	Standard Deviation

Source	1.80	4.40	3.11	.54
Certainty	1.00	3.50	2.24	.42
Speed	1.00	3.80	1.99	.41
Structure	1.71	4.29	2.82	.43
Stability	1.43	4.29	2.67	.54

These descriptive statistics indicate that, among all SCEBS participants, students reported the most sophisticated epistemological beliefs (as demonstrated by the lowest mean value of $M = 1.99$) in the speed of learning epistemological beliefs dimension. These students reported the least sophisticated epistemological beliefs ($M = 3.11$) in the source of knowledge dimension.

Epistemological beliefs and gender. In order to determine the extent to which participating students' epistemological beliefs differed according to their gender, a multiple analysis of variance (MANOVA) was employed. Dependent variables included all five dimensions of epistemological beliefs represented within the EBI component of the SCEBS—source of knowledge, certainty of knowledge, structure of knowledge, speed of learning, and stability of knowledge. The independent variable associated with this analysis was gender.

Results of the MANOVA indicated no statistically significant differences between the epistemological beliefs of males (n = 32) and those of females (n = 163), though subtle differences did exist with regard to several epistemological belief dimensions. Females' and males' beliefs in the source of knowledge, certainty of knowledge, speed of learning, and structure of knowledge dimensions of epistemological beliefs were nearly

identical, while females' beliefs in terms of the stability of knowledge were slightly more sophisticated than those of their male counterparts. This difference approached but did not meet the level of statistical significance ($F_{(1, 196)} = 2.210, p = .139$). It should be noted, though, that in each dimension of epistemological beliefs, females reported more sophisticated epistemological beliefs than did the participating males, small those these differences usually were. For detailed results of this analysis, see Table 6 below.

Table 6

MANOVA Results for Epistemological Beliefs According to Gender

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	Females	3.11	.53	.963
	Males	3.12	.59	
Certainty	Females	2.24	.42	.662
	Males	2.27	.42	
Speed	Females	1.98	.41	.357
	Males	2.05	.43	
Structure	Females	2.81	.41	.497
	Males	2.87	.52	
Stability	Females	2.64	.52	.139
	Males	2.80	.66	

Next, in order to determine whether subsets of the participating students' epistemological beliefs differed at a statistically significant level, students were divided into groups according to their education level, and MANOVAs similar to that described

above were conducted, first with only undergraduate students and again with only graduate students. Among the undergraduate students, females (n = 78) reported less sophisticated epistemological beliefs than did their male (n = 16) counterparts in all but one epistemological beliefs dimension—stability of knowledge. Though the observed differences between undergraduate males' and females' epistemological beliefs tended to favor the males, the differences were small and not statistically significant. For detailed results of this analysis, see Table 7 below.

Table 7

MANOVA Results for Undergraduate Students' Epistemological Beliefs According to Gender

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	Females	3.15	.54	.495
	Males	3.05	.45	
Certainty	Females	2.30	.47	.405
	Males	2.20	.27	
Speed	Females	1.99	.41	.858
	Males	1.98	.38	
Structure	Females	2.86	.41	.930
	Males	2.85	.59	
Stability	Females	2.56	.51	.363
	Males	2.70	.69	

Among the graduate student participants, female students (n = 85) reported more sophisticated epistemological beliefs than did their male (n = 16) counterparts in all five of the measured epistemological beliefs dimensions. Though none of the differences between females and males were statistically significant, differences in the speed of learning ($F_{(1, 100)} = 2.1, p = .151$) and certainty of knowledge ($F_{(1, 99)} = 2.52, p = .116$) dimensions approached levels of statistical significance. For detailed results of this analysis, see Table 8 below.

Table 8

MANOVA Results for Graduate Students' Epistemological Beliefs According to Gender

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	Females	3.08	.51	.477
	Males	3.19	.71	
Certainty	Females	2.18	.36	.116
	Males	2.35	.53	
Speed	Females	1.96	.41	.151
	Males	2.13	.47	
Structure	Females	2.76	.42	.296
	Males	2.88	.46	
Stability	Females	2.72	.51	.212
	Males	2.90	.64	

Epistemological beliefs and ethnicity. In order to determine the extent to which students' epistemological beliefs differed according to their ethnicity, a multiple analysis

of variance (MANOVA) was conducted. As was the case in the gender analysis above, dependent variables in this MANOVA included all five of the epistemological beliefs dimensions measured by the EBI component of the SCEBS—source of knowledge, certainty of knowledge, structure of knowledge, speed of learning, and stability of knowledge. The independent variable associated with this analysis was ethnicity. Participating students aligned themselves with one of the following ethnicities: African American, Asian/Pacific Islander, Caucasian, Hispanic, Native American, and an "Other" category which was selected by students who were not represented by any of the specific ethnicities listed above.

Preliminary descriptive statistical analyses indicated that the number of participants associated with several ethnicities (Asian/Pacific Islander, Hispanic, Native American, and Other) rendered it inappropriate for the researcher to rely on MANOVA results, so differences between these groups can best be characterized through a discussion of the relationship between their mean epistemological beliefs in the five dimensions. In general, Asian/Pacific Islander participants reported the most sophisticated epistemological beliefs in the source of knowledge dimension, while those who self-identified as Other reported the least sophisticated epistemological beliefs. In the certainty of knowledge epistemological beliefs dimension, Native American students reported the most sophisticated epistemological beliefs, while the students who identified as Other reported the least sophisticated beliefs. Asian/Pacific Islander students reported the most sophisticated epistemological beliefs in terms of the speed of learning dimension, while their Native American counterparts reported the least sophisticated epistemological beliefs in this dimension. In the structure of knowledge dimension,

Asian/Pacific Islander students reported the most sophisticated beliefs, and the students who self-identified as Native American reported the least sophisticated beliefs. Finally, in terms of the stability of knowledge dimension, Asian/Pacific Islander students reported the most sophisticated epistemological beliefs, while the Native American students again reported the least sophisticated epistemological beliefs. For a detailed breakdown of the comparisons between group means within each epistemological beliefs dimension, see Table 9 below.

Table 9

Descriptive Statistics for Students' Epistemological Beliefs According to Ethnicity

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
African American (n = 26)	3.16	.62	2.31	.41	2.00	.50	2.92	.55	2.62	.47
Asian/Pacific Islander (n = 7)	2.97	.35	2.34	.52	1.83	.48	2.78	.46	2.49	.45
Caucasian (n = 144)	3.08	.52	2.21	.41	1.98	.38	2.79	.41	2.66	.55
Hispanic (n = 11)	3.29	.61	2.31	.42	2.09	.57	2.87	.54	2.68	.55
Native American (n = 2)	3.30	.14	2.19	.44	2.30	.14	3.07	.10	3.21	.71
Other	3.40	.71	2.38	.32	2.05	.19	3.00	.45	3.14	.84

(n = 4)

Since several ethnicity categories included too few participants for a MANOVA to be appropriate, MANOVA was instead implemented in order to determine whether statistically significant differences existed between African American (n = 26) and Caucasian (n = 144) students' epistemological beliefs. Caucasian students reported slightly more sophisticated epistemological beliefs in all dimensions except for stability of knowledge, but the differences between groups were not statistically significant.

Epistemological beliefs and age. In order to determine whether statistically significant differences existed between the different age groups represented among the study's participants, a multiple analysis of variance (MANOVA) was conducted. The independent variable in this MANOVA (age) included levels represented by each of the age categories with which students self-identified. These categories included 19 years or younger, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 39 years, 40 to 44 years, and 45 years or older. The dependent variables included in the MANOVA included each of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS.

MANOVA results indicated small, not statistically significant differences in epistemological beliefs among the differently aged participants. In the source of knowledge dimension, 35- to 39-year-olds reported the most sophisticated epistemological beliefs, while those participants 19 years old or younger reported the least sophisticated beliefs. Similarly, in the certainty of knowledge dimension, 35- to 39-year-olds reported the most sophisticated epistemological beliefs, while those participants

45 years old or older reported the least sophisticated beliefs. With regard to the speed of learning dimension, students aged 35 to 39 years again reported the most sophisticated epistemological beliefs, while those participants aged 45 or more years reported the least sophisticated beliefs. Next, in terms of the structure of knowledge dimension, 30- to 34-year-old participants reported the most sophisticated beliefs, while participants 19 years old and younger reported the least sophisticated epistemological beliefs. Finally, in the stability of knowledge epistemological beliefs dimension, those participants 19 years old and younger reported the most sophisticated epistemological beliefs, while their 45 years and older counterparts reported the least sophisticated beliefs. See Table 10 for more detailed results from this MANOVA.

Table 10

MANOVA Results for Students' Epistemological Beliefs According to Age

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	≤ 19 (n = 5)	3.20	.57	.996
	20-24 (n = 72)	3.12	.57	
	25-29 (n = 32)	3.12	.44	
	30-34 (n = 26)	3.08	.57	
	35-39 (n = 20)	3.06	.45	
	40-44 (n = 14)	3.17	.66	
	≥ 45 (n = 26)	3.11	.54	
Certainty	≤ 19	2.17	.20	.616
	20-24	2.29	.44	
	25-29	2.22	.36	

	30-34	2.19	.53	
	35-39	2.10	.32	
	40-44	2.29	.37	
	≥ 45	2.24	.42	
	≤ 19	2.00	.32	
	20-24	1.94	.46	
	25-29	2.07	.38	
Speed	30-34	1.92	.36	.241
	35-39	1.87	.38	
	40-44	2.10	.41	
	≥ 45	2.11	.36	
	≤ 19	3.09	.69	
	20-24	2.81	.41	
	25-29	2/78	.46	
Structure	30-34	2.73	.51	.402
	35-39	2.75	.39	
	40-44	2.90	.48	
	≥ 45	2.93	.33	
	≤ 19	2.55	.76	
	20-24	2.61	.60	
Stability	25-29	2.68	.57	.511
	30-34	2.74	.52	
	35-39	2.59	.43	

40-44	2.63	.46
≥ 45	2.86	.41

Epistemological beliefs and academic experience. In order to determine whether statistically significant differences existed between the epistemological beliefs of students with different levels of educational experience, a multiple analysis of variance (MANOVA) was conducted. In this MANOVA, the dependent variables were all five of the epistemological beliefs dimensions measured by the EBI component of the SCEBS. The independent variable (academic experience) employed in this MANOVA featured the following levels: High School, Two years of undergraduate study, bachelor's degree, and master's degree. Students were asked to identify the highest level of education they had completed by selecting one of these options.

MANOVA results indicated no statistically significant differences, though differences between the age groups in the stability of knowledge epistemological beliefs dimension nearly met the level of statistical significance ($F_{(3, 195)} = 2.60, p = .053$). In this dimension, those students who had completed two years of undergraduate study reported the most sophisticated beliefs, while their counterparts with less than two years of undergraduate experience reported the least sophisticated epistemological beliefs. In the source of knowledge dimension, students who had earned a master's degree reported the most sophisticated epistemological beliefs, while those participants who had completed less than two years of undergraduate study reported the least sophisticated beliefs. Similarly, in the certainty of knowledge dimension, students with a master's degree reported the most sophisticated epistemological beliefs, while those participants who had completed less than two years of undergraduate study reported the least

sophisticated beliefs. With regard to the speed of learning dimension, students two years of undergraduate experience again reported the most sophisticated epistemological beliefs, while those participants who had less than two years of undergraduate college experience reported the least sophisticated beliefs. Next, in terms of the structure of knowledge dimension, participants who had earned a master's degree reported the most sophisticated beliefs, while the two groups of participants who had not yet earned a bachelor's degree reported the least sophisticated epistemological beliefs. The observed difference between groups in this dimension, too, neared the level of statistical significance ($F_{(3, 191)} = 1.65, p = .180$). See Table 11 below for more details related to this MANOVA.

Table 11

MANOVA Results for Students' Epistemological Beliefs According to Academic Experience

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	High School	3.34	.51	.360
	2 yrs. Undergrad.	3.11	.53	
	Bachelor's	3.14	.51	
	Master's	2.98	.63	
Certainty	High School	2.38	.55	.614
	2 yrs. Undergrad.	2.27	.44	
	Bachelor's	2.21	.36	

	Master's	2.20	.49	
Speed	High School	2.23	.23	.518
	2 yrs. Undergrad.	1.98	.40	
	Bachelor's	1.98	.40	
	Master's	2.00	.47	
Structure	High School	2.86	.29	.180
	2 yrs. Undergrad.	2.86	.45	
	Bachelor's	2.83	.42	
	Master's	2.65	.41	
Stability	High School	2.90	.56	.053
	2 yrs. Undergrad.	2.56	.54	
	Bachelor's	2.72	.57	
	Master's	2.82	.43	

Epistemological beliefs and prospective teaching grade level. In order to determine whether statistically significant differences existed between the epistemological beliefs of groups of students planning to teach different grade levels, a multiple analysis of variance (MANOVA) was conducted. In this MANOVA, the dependent variables included each of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS. The independent variable (prospective

teaching grade level) was divided into the following five levels: Early Childhood (n = 7), Elementary (n = 76), Secondary (n = 74), Other (n = 14), and a category called "Not Planning to Teach" (n = 24). This final category was to be selected by all those students who were enrolled in participating courses but who did not plan to teach after completing their collegiate study.

Results from this MANOVA indicated that, while differences existed between the various groups of participants planning to teach in different grade levels, none of these differences were statistically significant. In the speed of learning epistemological beliefs dimension, those students planning to teach in the Early Childhood grade levels reported the most sophisticated epistemological beliefs, while the students not planning to teach reported the least sophisticated beliefs. Though the differences between groups was not statistically significant, the differences did approach statistical significance ($F_{(4, 192)} = 1.87, p = .117$). In the source of knowledge dimension, those students who responded with the "Other" option reported the most sophisticated epistemological beliefs, while the students not planning to teach reported the least sophisticated beliefs. Again, though the differences observed between groups in this dimension were not statistically significant, the differences did approach the level of statistical significance ($F_{(4, 193)} = 1.62, p = .170$). For detailed results associated with this MANOVA, see Table 12 below.

Table 12

MANOVA Results for Students' Epistemological Beliefs According to Prospective Teaching Grade Level

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	Early Childhood	3.23	.21	.170

	Elementary	3.10	.52	
	Secondary	3.05	.53	
	Other	3.04	.60	
	Not teaching	3.34	.60	
Certainty	Early Childhood	2.46	.31	.597
	Elementary	2.26	.40	
	Secondary	2.20	.43	
	Other	2.24	.50	
	Not teaching	2.25	.43	
Speed	Early Childhood	1.83	.59	.117
	Elementary	1.93	.35	
	Secondary	2.00	.37	
	Other	2.06	.45	
	Not teaching	2.16	.58	
Structure	Early Childhood	2.80	.38	.893
	Elementary	2.82	.40	
	Secondary	2.83	.42	
	Other	2.70	.57	
	Not teaching	2.83	.52	
Stability	Early Childhood	2.51	.38	.213
	Elementary	2.59	.50	
	Secondary	2.70	.56	
	Other	2.72	.41	

	Not teaching	2.86	.66

Epistemological beliefs and prospective teaching content area. In order to determine whether statistically significant differences existed between the epistemological beliefs of participating students separated into groups according to the content areas in which they planned to teach, a multiple analysis of variance (MANOVA) was conducted. In this MANOVA, the dependent variables included each of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS. The independent variable included in the MANOVA (prospective teaching content area) was divided into the following ten levels: English (n = 30), Foreign Languages (n = 4), Mathematics (n = 22), Arts (n = 10), PE/Health (n = 4), Sciences (n = 15), Social Studies (n = 13), Special Education (n = 37), Other (n = 36), and a category called "Not Planning to Teach" (n = 24) that was to be selected by all those students who were enrolled in participating courses but who did not plan to teach after completing their study. Since the Foreign Languages and PE/Health levels of the prospective teaching content area independent variable included too few participants for MANOVA to be viable, these students were removed from this calculation. Still, descriptive statistics regarding these students' epistemological beliefs are summarized in Table 13 below.

Table 13

Students' Epistemological Beliefs According to Prospective Teaching Content Area—Foreign Languages and PE/Health

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*

For. Lang. (n = 4)	3.40	.52	2.56	.22	1.95	.53	2.89	.54	2.43	.47
PE/Health (n = 4)	3.45	.41	2.56	.46	1.90	.35	3.00	.12	2.36	.14

The MANOVA including the remaining participating students indicated statistically significant differences ($F_{(7, 181)} = 2.20, p = .036$) between students' epistemological beliefs in the speed of learning dimension. The specific group-wise differences are explained below, but the group of students planning to teach mathematics reported the most sophisticated epistemological beliefs. Those students who reported not planning to teach after their graduation reported the least sophisticated beliefs in this dimension. Meanwhile, differences between student groups approached but did not meet the statistically significant level ($F_{(7, 182)} = 1.83, p = .085$) in the source of knowledge epistemological beliefs dimension. Again, prospective mathematics teachers reported the most sophisticated epistemological beliefs, while those students not planning to teach reported the least sophisticated epistemological beliefs. Differences between groups' beliefs in the three remaining dimensions were less pronounced and further from the level of statistical significance. In the certainty of knowledge dimension, prospective mathematics teachers again reported the most sophisticated beliefs, while the prospective special education teachers reported the least sophisticated beliefs. With regard to the structure of knowledge epistemological beliefs dimension, students who indicated plans to teach in "other" content areas reported the most sophisticated beliefs, while the prospective social studies teachers reported the least sophisticated beliefs. Finally, in the

stability of knowledge dimension, prospective social studies teachers indicated the most sophisticated beliefs, while those students not planning to teach reported the least sophisticated beliefs. For detailed results from this MANOVA, see Table 14 below.

Table 14

MANOVA Results for Students' Epistemological Beliefs According to Prospective Teaching Content Area

Dimension	Group	Mean (*m*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	English (n = 30)	2.95	.56	.085
	Math (n = 22)	2.90	.62	
	Arts (n = 10)	3.02	.45	
	Sciences (n = 15)	3.17	.52	
	Soc. Stud. (n = 13)	3.26	.34	
	Spec. Ed. (n = 37)	3.11	.46	
	Other (n = 36)	3.10	.52	
	Not teaching (n = 24)	3.34	.60	
Certainty	English	2.17	.40	.855
	Math	2.13	.51	
	Arts	2.21	.58	
	Sciences	2.26	.42	
	Soc. Stud.	2.19	.33	

	Spec. Ed.	2.29	.43	
	Other	2.27	.33	
	Not teaching	2.25	.43	
Speed	English	1.93	.34	.036*
	Math	1.84	.32	
	Arts	2.04	.43	
	Sciences	2.08	.42	
	Soc. Stud.	2.12	.34	
	Spec. Ed.	2.06	.34	
	Other	1.86	.41	
	Not teaching	2.16	.58	
Structure	English	2.77	.42	.502
	Math	2.82	.48	
	Arts	2.87	.45	
	Sciences	2.73	.45	
	Soc. Stud.	2.99	.56	
	Spec. Ed.	2.89	.35	
	Other	2.71	.38	
	Not teaching	2.83	.52	
Stability	English	2.65	.43	.567
	Math	2.76	.53	
	Arts	2.61	.56	
	Sciences	2.73	.79	

	Soc. Stud.	2.54	.47
	Spec. Ed.	2.70	.55
	Other	2.57	.46
	Not teaching	2.86	.66

*- Statistically significant at the $\alpha = .05$ level.

As the differences between prospective content area teaching groups were found to be statistically significant within the speed of learning epistemological beliefs dimension, the researcher conducted follow-up post hoc tests in order to determine between which specific groups of students the statistically significant differences were found. Post hoc least significant differences (LSD) tests were conducted, and they indicated a statistically significant difference between prospective English teachers' beliefs and those of their counterparts not planning to teach ($p = .042$) with the English teachers reporting more sophisticated epistemological beliefs in this dimension than those participants not planning to teach. In the same dimension (speed of learning), statistically significant differences were observed between the prospective math teachers and their counterparts planning to teach social studies ($p = .042$) as well as those planning to teach special education ($p = .041$) and those students not planning to teach ($p = .007$). In all three cases, the prospective math teachers' beliefs were found to be more sophisticated than those of their peers. Next, still in the speed of learning dimension, a statistically significant difference was identified between the beliefs of prospective social studies teachers and those of the students planning to teach in "other" content areas ($p = .043$). In this instance, the prospective social studies teachers reported less sophisticated beliefs than did their peers. Similarly, a statistically significant difference was identified

between the beliefs of prospective special education teachers and those of the students planning to teach in "other" content areas ($p = .033$). In this instance, the prospective special education teachers reported less sophisticated beliefs than did their peers. Finally, statistically significant differences were observed between the speed of learning epistemological beliefs of those students not planning to teach and those students planning to teach in "other" content areas ($p = .005$), with the students planning to teach "other" content areas reporting more sophisticated beliefs than those beliefs reported by the students not planning to teach.

Student Beliefs Development and Demographic and Academic Characteristics

The following sections are dedicated to explanations of the analyses conducted in order to determine whether different subgroups of students' epistemological beliefs developed at different rates during the course of the study, in the contexts of the participating courses in which they were enrolled. In these analyses, students were arranged into groups according to their statuses with regard to the demographic and academic characteristic variables. As these analyses were designed in order to address students' development, epistemological beliefs as measured by both SCEBS and SCEBS-2 were necessary. As such, only those students who completed both these surveys were included in the analyses discussed in the sections below.

Development and gender. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the two genders of students' epistemological beliefs after holding constant the students' SCEBS epistemological beliefs, a one-way MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant

differences between the two groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the two groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was gender. This variable included the two obvious levels—male and female. In this analysis, the dependent variables included the students' epistemological beliefs as expressed in their responses to items dealing with each of the five epistemological beliefs dimensions included in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Covariates included in this analysis were all five dimensions of students' epistemological beliefs as measured by the SCEBS. The beliefs reported on the SCEBS can be understood as the pre-test within this study, so covarying for these scores allowed the researcher to identify the variance between groups' SCEBS-2 (post-test) beliefs after controlling for differences in their SCEBS (pre-test) beliefs. Such control allowed the researcher to determine whether students of different genders experienced epistemological beliefs development at a statistically significantly different level. Only those students who completed both the SCEBS and the SCEBS-2 were included in the current analysis.

Results of this MANCOVA indicated that, while the SCEBS-2 epistemological beliefs indicated that females reported more sophisticated epistemological beliefs than their male peers in three of the five epistemological beliefs dimensions (source of knowledge, structure of knowledge, and stability of knowledge) assessed on the SCEBS-

2, males reported more sophisticated epistemological beliefs than did their female counterparts in the remaining two epistemological beliefs dimensions.

Once the adjusted SCEBS-2 means were taken into consideration to account for the fact that this procedure held constant students' SCEBS epistemological beliefs, it became clear that, during the course of the study, participating males experienced more epistemological beliefs development than did their female counterparts in each of the five epistemological beliefs dimensions, and in the case of the certainty of knowledge dimension, this difference was statistically significant ($F_{(1, 91)} = 6.64, p = .012$). Additionally, males' epistemological beliefs developed at a rate that was nearly statistically significantly higher than did their female counterparts in the speed of learning dimension ($F_{(1, 91)} = 2.84, p = .095$). See Table 15 for detailed results from this MANCOVA.

Table 15

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Students' Gender

Dimension	Group	Mean (*m*)	Adjusted Mean (*am*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	Female (n = 83)	3.01	3.04	.54	.894
	Male (n = 15)	3.20	3.03	.68	
Certainty	Female	2.12	2.14	.42	.012*
	Male	2.00	1.93	.35	

Speed	Female	1.96	1.97	.39	.095
	Male	1.88	1.81	.51	
Structure	Female	2.69	2.71	.45	.798
	Male	2.84	2.68	.52	
Stability	Female	2.66	2.68	.59	.769
	Male	2.76	2.64	.79	

*- Statistically significant at the $\alpha = .05$ level.

Development and ethnicity. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the ethnic groups of students' epistemological beliefs after holding constant the students' SCEBS epistemological beliefs, a one-way MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the two groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was ethnicity. This variable included only two levels in this case—African American and Caucasian—because the other ethnic groups included insufficient numbers of cases. In this analysis, the dependent variables included the students' epistemological beliefs as expressed in their responses to items dealing with each of the five epistemological beliefs dimensions included in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Covariates included in this analysis were all five dimensions of students' epistemological beliefs as measured by the SCEBS. The beliefs reported on the SCEBS can be understood as the pre-test within this study, so covarying for these scores allowed the researcher to identify the variance between groups' SCEBS-2 (post-test) beliefs after controlling for differences in their SCEBS (pre-test) beliefs. Such control allowed the researcher to determine whether students of different genders experienced epistemological beliefs development at a statistically significantly different level. Only those students who completed both the SCEBS and the SCEBS-2 were included in the current analysis.

Results of this MANCOVA indicated that African American students reported more sophisticated epistemological beliefs than did their Caucasian peers in three of the five epistemological beliefs dimensions (source of knowledge, certainty of knowledge, and speed of learning) assessed through the SCEBS-2. Caucasian students reported more sophisticated epistemological beliefs than did their African American counterparts in the remaining two epistemological beliefs dimensions, though differences in these dimensions were nearly small enough to be regarded as negligible.

Once the adjusted SCEBS-2 means were taken into consideration to account for the fact that this procedure held constant students' SCEBS epistemological beliefs, it became clear that, while no statistically significant differences were identified between the development of the two ethnic groups of students' epistemological beliefs, African Americans' epistemological beliefs developed more during the course of the study, in the contexts of the courses in which these students were enrolled, than did those of their Caucasian peers. See Table 16 for detailed results from this MANCOVA.

Table 16

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Students' Ethnicity

Dimension	Group	Mean (*m*)	Adjusted Mean (*am*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	African American (n = 8)	2.85	2.91	.48	.858
	Caucasian (n = 78)	3.04	3.04	.58	
Certainty	Afr. American	2.08	2.05	.35	.409
	Caucasian	2.11	2.12	.41	
Speed	Afr. American	1.93	1.90	.44	.632
	Caucasian	1.96	1.95	.41	
Structure	Afr. American	2.71	2.67	.61	.786
	Caucasian	2.70	2.70	.47	
Stability	Afr. American	2.73	2.59	.65	.577
	Caucasian	2.70	2.70	.64	

Development and age. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the age groups of students' epistemological beliefs after holding constant the students' SCEBS epistemological beliefs, a seven-way MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the two groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the seven student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was age. This variable included the following levels: 19 years or younger, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 39 years, 40 to 44 years, and 45 years or older. In this analysis, the dependent variables included the students' epistemological beliefs as expressed in their responses to items dealing with each of the five epistemological beliefs dimensions included in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Covariates included in this analysis were all five dimensions of students' epistemological beliefs as measured by the SCEBS. The beliefs reported on the SCEBS can be understood as the pre-test within this study, so covarying for these scores allowed the researcher to identify the variance between groups' SCEBS-2 (post-test) beliefs after controlling for differences in their SCEBS (pre-test) beliefs. Such control allowed the researcher to determine whether students of different genders experienced epistemological beliefs development at a statistically significantly different level. Only

those students who completed both the SCEBS and the SCEBS-2 were included in the current analysis.

Results of this MANCOVA indicated that, at the time of the SCEBS-2 administration, within the source of knowledge dimension, students within the 35-39 years age group reported the most sophisticated epistemological beliefs, while their peers in the 40-44 years age group reported the least sophisticated beliefs. In the certainty of knowledge dimension, students aged 20-24 years reported the most sophisticated beliefs, while the students older than 45 years reported the least sophisticated beliefs. Next, within the speed of learning dimension, students between the ages of 35 and 29 reported the most sophisticated beliefs, while the students aged 19 years or younger reported the least sophisticated beliefs. Within the structure of knowledge dimension, students aged between 35 and 39 years reported the most sophisticated beliefs, while the students older than 45 years reported the least sophisticated beliefs. Finally, in the stability of knowledge dimension, students aged between 20 and 24 years reported the most sophisticated epistemological beliefs, while their slightly older peers in the 25-29 years age group reported the least sophisticated beliefs.

Once the adjusted SCEBS-2 means were taken into consideration to account for the fact that this procedure held constant students' SCEBS epistemological beliefs, it became clear that, within the source of knowledge dimension, students aged between 25 and 29 years experienced the most epistemological beliefs growth during the course of the study, while those students aged 45 years or more experienced the least growth. Next, in the certainty of knowledge dimension, students between 20 and 24 years old experienced the most growth, while their 40- to 44-year-old peers experienced the least

growth. In the speed of learning dimension and structure of knowledge dimensions, students between the ages of 35 and 39 years experienced the most development, while their youngest counterparts, those students 19 years old or less, experiences the least development during the course of the study. While no statistically significant differences were identified between the development of the different age groups of students' epistemological beliefs through this analysis, the difference identified in the stability of knowledge dimension nearly met the requirements for consideration as statistically significant ($F_{(6, 86)} = 2.092$, $p = .062$). Since this difference in development was not statistically significant, and in an attempt to avoid type one error, follow-up analyses were not conducted. See Table 17 for detailed results from this MANCOVA.

Table 17

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Students' Age

Dimension	Group	Mean (*m*)	Adjusted Mean (*am*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	≤ 19 (n = 3)	3.00	3.02	.40	.997
	20-24 (n = 28)	3.00	3.02	.63	
	25-29 (n = 17)	3.00	3.01	.54	
	30-34 (n = 16)	3.03	3.06	.49	
	35-39 (n = 12)	2.98	3.02	.56	

	40-44 (n = 7)	3.26	3.08	.62	
	≥ 45 (n = 13)	3.15	3.10	.68	
Certainty	≤ 19	2.17	2.16	.26	.851
	20-24	2.03	2.04	.40	
	25-29	2.10	2.11	.37	
	30-34	2.13	2.16	.57	
	35-39	2.04	2.08	.36	
	40-44	2.16	2.17	.44	
	≥ 45	2.28	2.16	.36	
Speed	≤ 19	2.27	2.22	.42	.754
	20-24	1.88	1.92	.43	
	25-29	1.99	1.97	.42	
	30-34	1.95	2.00	.31	
	35-39	1.85	1.86	.48	
	40-44	1.97	1.91	.51	
	≥ 45	2.08	1.97	.37	
Structure	≤ 19	2.86	2.86	.38	.506
	20-24	2.77	2.74	.43	
	25-29	2.76	2.75	.57	
	30-34	2.50	2.63	.40	
	35-39	2.48	2.54	.29	

	40-44	2.71	2.71	.68	
	≥ 45	2.96	2.83	.42	
Stability	≤ 19	2.76	2.76	.50	.062
	20-24	2.49	2.58	.67	
	25-29	2.92	2.93	.66	
	30-34	2.69	2.70	.59	
	35-39	2.64	2.71	.68	
	40-44	2.67	2.62	.62	
	≥ 45	2.76	2.48	.50	

Development and academic experience. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the groups of students who had completed different levels of education after holding constant the students' SCEBS epistemological beliefs, a four-way MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the four groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the four student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was academic experience. This variable included the following levels: High School, Two years of undergraduate study, bachelor's degree, and master's degree. In this analysis, the dependent variables included the students' epistemological beliefs as expressed in their responses to items dealing with

each of the five epistemological beliefs dimensions included in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Covariates included in this analysis were all five dimensions of students' epistemological beliefs as measured by the SCEBS. The beliefs reported on the SCEBS can be understood as the pre-test within this study, so covarying for these scores allowed the researcher to identify the variance between groups' SCEBS-2 (post-test) beliefs after controlling for differences in their SCEBS (pre-test) beliefs. Such control allowed the researcher to determine whether students of different genders experienced epistemological beliefs development at a statistically significantly different level. Only those students who completed both the SCEBS and the SCEBS-2 were included in the current analysis.

Results of this MANCOVA indicated that, at the time of SCEBS-2 implementation, within the source of knowledge dimension, students who had completed two years of undergraduate study reported the most sophisticated epistemological beliefs, while their peers who had completed bachelor's degrees reported the least sophisticated beliefs. In the certainty of knowledge dimension, students who had earned bachelor's degrees reported the most sophisticated beliefs, while the students who had only completed high school reported the least sophisticated beliefs. Next, within the speed of learning dimension, students who had completed high school reported the most sophisticated beliefs, while the students who had earned a bachelor's degree reported the least sophisticated beliefs. Within the structure of knowledge dimension, students who had completed a master's degree reported the most sophisticated beliefs, while the

students who had completed high school reported the least sophisticated beliefs. Finally, in the stability of knowledge dimension, students who had completed high school reported the most sophisticated epistemological beliefs, while the students who had completed bachelor's degrees reported the least sophisticated beliefs.

Once the adjusted SCEBS-2 means were taken into consideration to account for the fact that this procedure held constant students' SCEBS epistemological beliefs, it became clear that, while no statistically significant differences were identified between the development of the different groups of students' epistemological beliefs, students with two years of undergraduate work experienced the most growth, while those who had completed only high school experienced the least growth in the source of knowledge dimension. In the certainty of knowledge dimension, students who had only completed high school experienced the most growth, while their counterparts who had earned master's degrees experienced the least growth. In both the speed of learning and the stability of knowledge dimensions, those participants who had completed only high school once again experienced the most growth, while their peers who had earned bachelor's degrees experienced the least growth. In the structure of knowledge dimension, students who had earned master's degrees experienced the most growth, while those participating students who had only completed high school experienced the least growth. See Table 18 for detailed results from this MANCOVA.

Table 18

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Students' Academic Experience

Dimension	Group	Mean (*m*)	Adjusted	Stan. Dev.	Significance

			Mean (*am*)	(*sd*)	(*p*)
Source	High School (n = 3)	3.07	3.10	.42	.905
	2 yrs. Undergrad. (n = 43)	3.00	3.01	.55	
	Bachelor's (n = 37)	3.10	3.07	.59	
	Master's (n = 15)	3.02	3.04	.64	
Certainty	High School	2.42	2.06	.89	.581
	2 yrs. Undergrad.	2.13	2.13	.43	
	Bachelor's	2.04	2.07	.39	
	Master's	2.15	2.16	.33	
Speed	High School	1.87	1.66	.61	.403
	2 yrs. Undergrad.	1.93	1.92	.40	
	Bachelor's	1.98	2.00	.44	
	Master's	1.94	1.95	.36	
Structure	High School	2.86	2.78	.14	.724
	2 yrs. Undergrad.	2.74	2.69	.44	

	Bachelor's	2.74	2.75	.52	
	Master's	2.51	2.63	.44	
Stability	High School	2.43	2.41	.62	.558
	2 yrs. Undergrad.	2.62	2.66	.66	
	Bachelor's	2.77	2.73	.65	
	Master's	2.65	2.61	.43	

Development and prospective teaching grade levels. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the prospective teaching grade level groups of students' epistemological beliefs after holding constant the students' SCEBS epistemological beliefs, a five-way MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the five groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the four student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was prospective teaching grade level. This variable included the following levels: Early Childhood, Elementary, Secondary, Other, and a category called "Not Planning to Teach." In this analysis, the dependent variables included the students' epistemological beliefs as expressed in their responses to items dealing with each of the five epistemological beliefs dimensions

included in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Covariates included in this analysis were all five dimensions of students' epistemological beliefs as measured by the SCEBS. The beliefs reported on the SCEBS can be understood as the pre-test within this study, so covarying for these scores allowed the researcher to identify the variance between groups' SCEBS-2 (post-test) beliefs after controlling for differences in their SCEBS (pre-test) beliefs. Such control allowed the researcher to determine whether students of different genders experienced epistemological beliefs development at a statistically significantly different level. Only those students who completed both the SCEBS and the SCEBS-2 were included in the current analysis.

Results of this MANCOVA indicated that, in the context of the courses in which participating students were enrolled, at the time of SCEBS-2 administration, within the source of knowledge dimension, students planning to teach in the "other" category reported the most sophisticated epistemological beliefs, while their peers not planning to teach reported the least sophisticated beliefs. In the certainty of knowledge dimension, students who plan to teach at the secondary level reported the most sophisticated beliefs, while the students who planned to teach in the early childhood grade levels and those who plan to teach in the "other" category reported the least sophisticated beliefs. Next, within both the speed of learning dimension and the structure of knowledge dimension, students who planned to teach in the "other" category reported the most sophisticated beliefs, while the students not planning to teach reported the least sophisticated beliefs. Finally, in the stability of knowledge dimension, students who planned to teach in the

early childhood grade levels reported the most sophisticated epistemological beliefs, while the students not planning to teach reported the least sophisticated beliefs.

Once the adjusted SCEBS-2 means were taken into consideration to account for the fact that this procedure held constant students' SCEBS epistemological beliefs, it became clear that, while no statistically significant differences were identified between the development of the different groups of students' epistemological beliefs through this analysis, in the source of knowledge dimension, students planning to teach in the early childhood or secondary grade levels experiences the most growth, while those students not planning to teach experienced the least growth. In the certainty of knowledge dimension, students planning to teach in the early childhood grade levels experienced the most development, while their peers not planning to teach experienced the least development. In the speed of learning dimension, students planning to teach in "other" grade levels experienced the most development, while their peers not planning to teach as well as those planning to teach in the early childhood grade levels experienced the least growth. In the structure of knowledge dimension, students planning to teach "other" grade levels experienced the most development, while their peers not planning to teach experienced the least development in this dimension. Finally, in the stability of knowledge dimension, students planning to teach at the secondary level experienced the most development, while their peers not planning to teach experienced the least development. Again, since none of the differences between the groups' development were statistically significant, follow-up ANCOVAs were not conducted. See Table 19 for detailed results from this MANCOVA.

Table 19

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Students' Academic Experience

Dimension	Group	Mean (*m*)	Adjusted Mean (*am*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	Early Childhood (n = 3)	3.07	3.01	.23	.923
	Elementary (n = 35)	3.02	3.04	.59	
	Secondary (n = 31)	3.02	3.01	.57	
	Other (n = 12)	2.97	3.04	.56	
	Not teaching (n = 15)	3.20	3.12	.61	
Certainty	Early Childhood	2.17	2.02	.14	.745
	Elementary	2.15	2.14	.45	
	Secondary	2.02	2.05	.41	
	Other	2.17	2.14	.46	
	Not teaching	2.13	2.16	.36	
Speed	Early Childhood	1.93	2.00	.31	.938

	Elementary	1.94	1.93	.44	
	Secondary	1.94	1.95	.36	
	Other	1.90	1.90	.46	
	Not teaching	2.05	2.00	.46	
Structure	Early Childhood	2.62	2.69	.30	.327
	Elementary	2.75	2.72	.41	
	Secondary	2.72	2.71	.47	
	Other	2.50	2.53	.58	
	Not teaching	2.77	2.82	.55	
Stability	Early Childhood	2.48	2.72	.50	.484
	Elementary	2.68	2.71	.60	
	Secondary	2.59	2.58	.55	
	Other	2.74	2.73	.71	
	Not teaching	2.84	2.74	.80	

Development and prospective teaching content area. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the prospective teaching content area groups of students' epistemological beliefs after holding constant the students' SCEBS epistemological beliefs, a MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the five

groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the four student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was prospective teaching content area. This variable included the following levels: English, Foreign Languages, Mathematics, Arts, PE/Health, Sciences, Social Studies, Special Education, Other, and a category called "Not Planning to Teach" that was to be selected by all those students who were enrolled in participating courses but who did not plan to teach after completing their study. Since the Foreign Languages level of the prospective teaching content area independent variable included too few participants for MANCOVA to be viable, these students were removed from this calculation In this analysis, the dependent variables included the students' epistemological beliefs as expressed in their responses to items dealing with each of the five epistemological beliefs dimensions included in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Covariates included in this analysis were all five dimensions of students' epistemological beliefs as measured by the SCEBS. The beliefs reported on the SCEBS can be understood as the pre-test within this study, so covarying for these scores allowed the researcher to identify the variance between groups' SCEBS-2 (post-test) beliefs after controlling for differences in their SCEBS (pre-test) beliefs. Such control allowed the researcher to determine whether students of different genders experienced epistemological beliefs development at a statistically significantly different level. Only

those students who completed both the SCEBS and the SCEBS-2 were included in the current analysis.

Results of this MANCOVA indicated that, at the time of SCEBS-2 administration, within the contexts of the participating courses in which participating students were enrolled, within the source of knowledge dimension, students planning to teach English reported the most sophisticated epistemological beliefs, while their peers not planning to teach reported the least sophisticated beliefs. In the certainty of knowledge dimension, students who plan to teach sciences reported the most sophisticated beliefs, while the students who planned to teach special education or "other" reported the least sophisticated beliefs. Next, within both the speed of learning dimension, students who planned to teach sciences reported the most sophisticated beliefs, while the students not planning to teach reported the least sophisticated beliefs. Within the structure of knowledge dimension, those students planning to teach in the sciences reported the most sophisticated epistemological beliefs, while their peers not planning to teach reported the least sophisticated epistemological beliefs in this dimension. Finally, in the stability of knowledge dimension, students who planned to teach in the arts reported the most sophisticated epistemological beliefs, while the students not planning to teach reported the least sophisticated beliefs.

Once the SCEBS-2 epistemological beliefs means were adjusted for the SCEBS beliefs that were hold constant in the MANCOVA procedure, it became clear that, while no statistically significant differences were identified between the development of the different groups of students' epistemological beliefs through this analysis, students planning to teach English experienced the most growth in the source of knowledge

dimension, while their peers not planning to teach experienced the least growth in this dimension. In the certainty of knowledge dimension, prospective social studies teachers experienced the most development, while prospective math teachers developed the least during the study. In the speed of learning dimension, prospective science teachers experienced the most development, while prospective special education teachers experienced the least. In the structure of knowledge dimension, prospective social studies teachers experienced the most development, while their peers not planning to teach experienced the least development in this dimension. Finally, in the stability of knowledge dimension, students planning to teach in the arts experienced the most development, while prospective special education teachers again experienced the least development during the course of the study, in the contexts of the courses in which they were enrolled. See Table 20 for detailed results from this MANCOVA.

Table 20

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Students' Academic Experience

Dimension	Group	Mean (*m*)	Adjusted Mean (*am*)	Stan. Dev. (*sd*)	Significance (*p*)
Source	English (n = 13)	2.82	2.89	.50	.779
	Math (n = 12)	2.85	3.08	.69	
	Arts (n = 6)	3.07	3.10	.53	
	Sciences (n = 5)	3.08	2.92	.54	

	Soc. Stud. (n = 7)	3.11	3.08	.40	
	Spec. Ed. (n = 18)	3.08	3.01	.67	
	Other (n = 18)	3.06	3.07	.43	
	Not teaching (n = 15)	3.20	3.12	.61	
Certainty	English	2.07	2.12	.44	.926
	Math	2.18	2.19	.49	
	Arts	2.08	2.10	.73	
	Sciences	1.90	2.04	.32	
	Soc. Stud.	1.96	1.97	.33	
	Spec. Ed.	2.15	2.09	.49	
	Other	2.15	2.11	.27	
	Not teaching	2.13	2.16	.36	
Speed	English	1.95	1.99	.35	.882
	Math	1.97	1.96	.42	
	Arts	1.90	1.95	.37	
	Sciences	1.76	1.81	.43	
	Soc. Stud.	2.03	1.90	.37	
	Spec. Ed.	2.03	2.01	.28	
	Other	1.87	1.90	.52	
	Not teaching	2.05	2.00	.46	

Structure	English	2.66	2.71	.49	.466
	Math	2.76	2.78	.42	
	Arts	2.67	2.66	.38	
	Sciences	2.54	2.55	.51	
	Soc. Stud.	2.65	2.51	.62	
	Spec. Ed.	2.70	2.66	.36	
	Other	2.69	2.72	.51	
	Not teaching	2.77	2.81	.55	
Stability	English	2.63	2.67	.53	.728
	Math	2.68	2.59	.52	
	Arts	2.21	2.39	.38	
	Sciences	2.63	2.61	.78	
	Soc. Stud.	2.65	2.73	.82	
	Spec. Ed.	2.79	2.75	.55	
	Other	2.65	2.68	.67	
	Not teaching	2.84	2.74	.80	

Student Beliefs Development and Course Characteristics

The following sections are dedicated to explanations of the analyses conducted in order to determine whether different subgroups of students' epistemological beliefs developed at different rates during the course of the study, in the contexts of the participating courses in which they were enrolled. In these analyses, students were arranged into groups according to the characteristics of the courses in which they were

enrolled. As these analyses were designed in order to address students' development, epistemological beliefs as measured by both SCEBS and SCEBS-2 were necessary. As such, only those students who completed both these surveys were included in the analyses discussed in the sections below.

Epistemological beliefs and course delivery methodology. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the groups of students enrolled in courses delivered differently after holding constant the students' SCEBS epistemological beliefs, a MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the four groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the four student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was the delivery methodology employed in participating courses. This course delivery methodology variable included the following levels: Face-to-face, Distance synchronous, Distance synchronous streaming, and Distance web-based. The dependent variables employed in this MANCOVA included each of the five dimensions of epistemological beliefs measured by the EBI component of the SCEBS-2. In simple terms, these SCEBS-2 epistemological beliefs can be regarded as post-test scores. For summary descriptive statistics pertaining to the different groups of students' epistemological beliefs as measured by the SCEBS and the SCEBS-2, see Tables 21 and 22 below. Please note that only those students who participated in both the SCEBS and the SCEBS-2 are included in these analyses.

Table 21

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Course Delivery Methodology

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Face-to-face (n = 57)	3.03	.61	2.17	.47	1.99	.41	2.70	.48	2.71	.62
Dist.; synch. (n = 23)	3.13	.52	2.19	.34	1.89	.46	2.81	.42	2.59	.61
Dist.; synch; stream. (n = 9)	3.09	.62	2.25	.63	1.93	.17	2.56	.35	2.70	.39
Dist.; web (n = 9)	3.33	.60	2.03	.21	2.02	.42	2.87	.39	2.44	.35

Table 22

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Course Delivery Methodology

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Face-to-face (n = 57)	3.01	.57	2.13	.43	1.96	.39	2.66	.49	2.73	.69

Dist.; synch. (n = 23)	2.92	.46	2.03	.36	1.77	.47	2.81	.40	2.54	.58
Dist.; synch; stream. (n = 9)	3.24	.67	2.24	.52	2.02	.27	2.54	.55	2.70	.56
Dist.; web (n = 9)	3.36	.60	2.06	.34	2.22	.31	2.89	.33	2.60	.20

These descriptive statistics indicate that, at the time of the SCEBS administration, students enrolled in distance learning, synchronous sections of participating courses reported the most sophisticated beliefs in the source of knowledge epistemological beliefs dimension, while their counterparts enrolled in distance learning, web-based courses reported the least sophisticated beliefs. Similarly, in the certainty of knowledge dimension, students enrolled in distance learning, synchronous sections of participating courses reported the most sophisticated beliefs, but in this case, the students enrolled in the distance learning, synchronous, video streaming sections of participating courses reported the least sophisticated beliefs. In the speed of learning dimension, students enrolled in distance learning, synchronous sections of participating courses again reported the most sophisticated beliefs, while their distance learning, web-based counterparts reported the least sophisticated beliefs. In terms of structure of knowledge, distance learning, synchronous, video streaming students reported the most sophisticated beliefs, while students enrolled in distance learning, web-based courses again reported the least sophisticated beliefs. Finally, within the stability of knowledge epistemological beliefs dimension, distance learning, synchronous students reported the most

sophisticated beliefs, while their face-to-face counterparts, for the first time, reported the least sophisticated beliefs.

These same general relationships were reflected when data from the SCEBS-2 were analyzed, comparing students who were enrolled in courses with different delivery methodologies. In other words, the student groups with the most sophisticated and least sophisticated beliefs in each epistemological beliefs dimension were the same in the SCEBS-2 as they were in the SCEBS.

The covariates included in the MANCOVA were each of the five dimensions of epistemological beliefs measured by the EBI component of the SCEBS. In simple terms, these SCEBS epistemological beliefs can be understood as pre-test scores. These covariates were includes in order to allow the researcher to determine the amount of variance in students' SCEBS-2 (post-test) epistemological beliefs that could be explained by the delivery methodology of the participating course in which they were enrolled after removing the amount of variance attributed to students' SCEBS (pre-test) epistemological beliefs.

Results of this MANCOVA indicated that, after holding constant students' epistemological beliefs as measured by SCEBS, the course delivery methodology did account for a statistically significant difference between the epistemological beliefs of students in two of the epistemological beliefs dimensions measured in the EBI component of the SCEBS-2. More specifically, statistically significant differences between students' beliefs were identified in the source of knowledge ($F_{(3, 89)} = 3.07, p = .032$) and the speed of learning ($F_{(3, 89)} = 4.00, p = .010$) epistemological beliefs dimensions. For more details related to this MANCOVA, see Table 23 below.

Table 23

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Course Delivery Method

Dimension	Sig. (p)
Source	.032*
Certainty	.381
Speed	.010*
Structure	.318
Stability	.549

*- Statistically significant at the $\alpha = .05$ level.

Pairwise comparisons (individual ANOVAs conducted after accounting for the covariates) resultant from the MANCOVA analysis allowed the researcher to identify the specific groups between which statistically significant differences in epistemological beliefs according to course delivery methodology exist. Within the source of knowledge dimension, statistically significant differences were identified between the beliefs of students enrolled in distance learning, synchronous courses and each of the other student groups—those students enrolled in face-to-face sections ($p = .047$), those students enrolled in distance learning, synchronous, video streaming sections ($p = .009$), and those students enrolled in distance learning, web-based courses ($p = .046$). In each case, students in the distance learning, synchronous courses experienced more epistemological beliefs development than did their counterparts.

Within the speed of learning dimension, statistically significant differences were identified between the beliefs of students enrolled in face-to-face sections and the

students enrolled in distance learning, web-based courses ($p = .032$). In this pairing, students from face-to-face sections experienced more epistemological beliefs development than did their counterparts in web-based courses. Much like the case in the source of learning dimension, statistically significant differences were also identified between the beliefs of students enrolled in distance learning, synchronous courses and two other groups of students—those enrolled in distance learning, synchronous, video streaming courses ($p = .045$) as well as those enrolled in distance learning, web-based courses ($p = .002$). In both these cases, students in distance, synchronous courses experienced statistically significantly more epistemological beliefs development in the context of the courses in which they were enrolled than did their counterparts.

Development and instructional strategies. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the groups of students exposed to different instructional strategies after holding constant the students' SCEBS epistemological beliefs, a MANCOVA was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the four groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the four student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

In this MANCOVA, the independent variable was participating instructors' use or non-use of instructional strategies designed to impact students' epistemological beliefs. Instructors were asked in the ISEBS to indicate whether or not they instructed their instruction was designed to impact students' epistemological beliefs, and instructors'

responses (yes/no) were recoded into a variable the researcher then used to separate students into groups. The dependent variables employed in this MANCOVA included each of the five dimensions of epistemological beliefs measured by the EBI component of the SCEBS-2. In simple terms, these SCEBS-2 epistemological beliefs can be regarded as post-test scores. For summary descriptive statistics pertaining to the different groups of students' epistemological beliefs as measured by the SCEBS and the SCEBS-2, see Tables 24 and 25 below. Please note that only those students who participated in both the SCEBS and the SCEBS-2 are included in these analyses.

Table 24

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Instructors' Use/Non-Use of Instructional Strategies Designed to Impact Students' Beliefs

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Yes (n = 65)	3.10	.60	2.22	.46	1.92	.40	2.74	.46	2.66	.60
No (n = 16)	3.15	.66	2.12	.46	2.15	.36	2.79	.32	2.73	.64

Table 25

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Instructors' Use/Non-Use of Instructional Strategies Designed to Impact Students' Beliefs

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Yes (n = 65)	3.03	.55	2.11	.44	1.96	.41	2.67	.47	2.65	.58
No (n = 16)	3.22	.68	2.17	.41	2.08	.44	2.88	.40	2.94	.78

In general, the descriptive statistics above indicate that the students who were enrolled in classes taught by instructors who reported designing instruction to impact students' epistemological beliefs held more sophisticated epistemological beliefs than did their counterparts in courses whose instructors did not report attempting to influence students' epistemological beliefs through instruction. This trend was true with respect to data from the SCEBS, in which students whose instructors tried to influence their epistemological beliefs reported more sophisticated beliefs than did their counterparts in four epistemological beliefs dimension—source of knowledge, speed of learning, structure of knowledge, and stability of knowledge. Only in the certainty of knowledge dimension did those students whose instructors did not try to influence students' epistemological beliefs report higher scores than those reported by their counterparts. Analysis of SCEBS-2 data indicated that, at the time of that instrument's implementation,

students whose instructors sought to influence their epistemological beliefs reported more sophisticated epistemological beliefs than those of their counterparts in each of the five epistemological beliefs dimensions measured by the EBI components of both the SCEBS and the SCEBS-2.

The covariates included in the MANCOVA were each of the five dimensions of epistemological beliefs measured by the EBI component of the SCEBS. In simple terms, these SCEBS epistemological beliefs can be understood as pre-test scores. These covariates were includes in order to allow the researcher to determine the amount of variance in students' SCEBS-2 (post-test) epistemological beliefs that could be explained by the instructors' reported use or non-use of instructional strategies designed to impact students' epistemological beliefs after removing the amount of variance attributed to students' SCEBS (pre-test) epistemological beliefs.

MANCOVA results indicated that, after holding students SCEBS epistemological beliefs constant, while the differences between the two groups of students' scores approached statistically significant levels in two epistemological beliefs dimensions (structure of knowledge [$F_{(1, 74)} = 3.38, p = .070$] and stability of knowledge [$F_{(1, 74)} = 3.67, p = .059$]), after controlling for students' SCEBS (pre-test) beliefs, while students taught by instructors who sought to influence their epistemological beliefs experienced more development during the study than did those students whose professors did not try to influence their epistemological beliefs, there were no statistically significant differences between the two groups of students' epistemological beliefs development that could be attributed to whether or not the students' instructors implemented instruction

designed to impact students' epistemological beliefs. See Table 26 for additional results from this MANCOVA.

Table 26

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Use/Non-Use of Instructional Strategies Designed to Impact Students' Beliefs

Dimension	Sig. (*p*)
Source	.178
Certainty	.179
Speed	.826
Structure	.070
Stability	.059

Next, in order to determine whether statistically significant differences in the development of students' epistemological beliefs during the course of the study (as measured by the EBI component of the SCEBS and SCEBS-2) existed with relation to whether instructors tried to influence students' epistemological beliefs explicitly or implicitly, a one-way multiple analysis of covariance (MANCOVA) was conducted. In this MANCOVA, the independent variable was the nature of the instruction—whether it sought to impact students' epistemological beliefs explicitly or implicitly. After instructors were asked in the ISEBS to indicate whether or not they instructed their instruction was designed to impact students' epistemological beliefs, those who responded "yes" were asked to indicate whether the instruction they provided with the intention of impacting students' epistemological beliefs was designed to impact students'

beliefs explicitly or implicitly. The dependent variables employed in this MANCOVA included each of the five dimensions of epistemological beliefs measured by the EBI component of the SCEBS-2. In simple terms, these SCEBS-2 epistemological beliefs can be regarded as post-test scores. For summary descriptive statistics pertaining to the different groups of students' epistemological beliefs as measured by the SCEBS and the SCEBS-2, see Tables 27 and 28 below. Please note that only those students who participated in both the SCEBS and the SCEBS-2 are included in these analyses.

Table 27

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to the Nature of Instruction Designed to Impact Students' Epistemological Beliefs

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Explicitly (n = 26)	3.25	.57	2.25	.47	2.00	.44	2.82	.51	2.72	.74
Implicitly (n = 40)	3.01	.60	2.19	.47	1.87	.36	2.69	.42	2.62	.50

Table 28

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to the Nature of Instruction Designed to Impact Students' Epistemological Beliefs

Group	Dimension				
	Source	Certainty	Speed	Structure	Stability

	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Explicitly (n = 26)	3.05	.67	2.10	.44	1.98	.41	2.68	.43	2.68	.56
Implicitly (n = 40)	3.03	.47	2.12	.44	1.94	.42	2.67	.49	2.63	.60

Descriptive analysis of students' epistemological beliefs as measured by the SCEBS indicates that, at the time of SCEBS administration, students receiving instruction from professors who sought to impact students' epistemological beliefs through explicit instructional strategies reported less sophisticated beliefs than did their peers whose professors sought to impact students' epistemological beliefs through implicit instructional strategies in each of the five epistemological beliefs dimensions measured in the EBI component of the SCEBS. Analysis of the SCEBS-2 data indicated that, while the gaps between the two groups' beliefs shrunk, those students who received implicit epistemological beliefs instruction reported more sophisticated epistemological beliefs than did their counterparts receiving explicit epistemological beliefs instruction in all but one epistemological beliefs dimension—certainty of knowledge.

MANCOVA results did not indicate statistically significant differences between the epistemological beliefs development of students who received explicit epistemological beliefs instruction and those who received implicit epistemological beliefs instruction in any dimension, after controlling for students' beliefs as measured by SCEBS (pre-test). For specific information resultant from this MANCOVA, see Table 29 below.

Table 29

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Use/Non-Use of Instructional Strategies Designed to Impact Students' Beliefs

Dimension	Sig. (*p*)
Source	.276
Certainty	.223
Speed	.684
Structure	.334
Stability	.787

Development and instructors' epistemological beliefs. In order to determine whether statistically significant differences existed between the SCEBS-2 epistemological beliefs of the students whose instructors reported sophisticated epistemological beliefs and those students whose instructors reported naïve epistemological beliefs after holding constant the students' SCEBS epistemological beliefs, a series of five one-way MANCOVAs was conducted. Since students' SCEBS epistemological beliefs were held constant in this analysis, statistically significant differences between the five groups' SCEBS-2 adjusted mean beliefs allowed the researcher to infer that the four student groups experienced statistically significantly different rates of development during the course of the study, in the contexts of the participating courses in which the students were enrolled.

The dependent variables included in each of these MANCOVAs were the five dimensions of students' epistemological beliefs as measured by the SCEBS-2.

The independent variables included in these analyses were instructors' memberships in either the "relatively naïve" or the "relatively sophisticated" epistemological beliefs groups. Since the ISEBS measured five epistemological belief dimensions, professors were simultaneously members of five epistemological beliefs groups that were not mutually exclusive. In other words, a professor's membership in the relatively sophisticated group with relation to any one of the epistemological beliefs dimensions did not preclude that professor's membership from the relatively naïve group with regard to any other dimension. Naïve and sophisticated groups were formed as a result of the researcher's analysis of descriptive statistics from the EBI component of the ISEBS. The researcher first identified the mean epistemological beliefs values based on all the participating professors' responses for each epistemological beliefs dimension. These mean scores were then used as cut-points. Finally, if a professor's epistemological beliefs in one dimension were more sophisticated (i.e., numerically lower) than the mean, that professor was included in the sophisticated group, but if a professor's epistemological beliefs in one dimension were less sophisticated (i.e., numerically higher) than the mean, that professor was included in the naïve group. Again, each of the professors' group memberships was then used as the independent variables in this five-way MANCOVA.

Prior to conducting these MANCOVAs, the researcher conducted descriptive analyses of participating students' epistemological beliefs as measured by both SCEBS and SCEBS-2 in order to provide the reader with a cursory understanding of the relationship between the two groups of students' scores. First, the researcher conducted a descriptive analysis based on professors' group membership with relation to the source of

knowledge epistemological beliefs dimension. See Tables 30 and 31 for results of these analyses.

Table 30

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Professors' Source of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 40)	3.07	.63	2.13	.47	2.01	.41	2.73	.43	2.73	.64
Sophisticated (n = 43)	3.15	.58	2.26	.45	1.93	.39	2.77	.45	2.61	.57

Data from the SCEBS indicated that students whose professors were included in the naïve source of knowledge group reported more sophisticated epistemological beliefs than did their counterparts studying under those professors included in the sophisticated source of knowledge group in three dimensions—source of knowledge, certainty of knowledge, and structure of knowledge. The students of professors included in the sophisticated source of knowledge group reported more sophisticated beliefs in both the speed of learning and the stability of knowledge dimensions.

Table 31

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Professors' Source of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 40)	3.14	.59	2.12	.42	2.04	.39	2.71	.44	2.76	.72
Sophisticated (n = 43)	3.01	.57	2.13	.45	1.93	.44	2.72	.48	2.66	.54

Descriptive analysis of the SCEBS-2 data indicated that students of professors in the sophisticated source of knowledge group reported more sophisticated epistemological beliefs in three dimensions—source of knowledge, speed of learning, and stability of knowledge. Students of professors in the naïve source of knowledge group reported more sophisticated beliefs than did their counterparts in the remaining two dimensions—certainty of knowledge and structure of knowledge.

The first MANCOVA was designed to determine whether a statistically significant difference existed between the epistemological beliefs development of those students whose professors reported sophisticated beliefs regarding the source of knowledge dimension and those students whose professors reported naïve beliefs regarding the source of knowledge dimension. Results indicated that no statistically significant differences existed between the development of the epistemological beliefs of students who studied under professors in the sophisticated source of knowledge group and the epistemological development of students who studied under the professors included in the naïve source of knowledge group, after controlling for students'

epistemological beliefs as measured by the SCEBS (pre-test). Only in the source of knowledge and speed of learning dimensions did the differences between groups of students' scores approach a statistically significant level. For more detailed results of this MANCOVA, see Table 32 below.

Table 32

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Source of Knowledge Group Membership

Dimension	Sig. (*p*)
Source	.176
Certainty	.741
Speed	.127
Structure	.852
Stability	.741

Next, the researcher conducted a descriptive analysis based on professors' group membership with relation to the certainty of knowledge epistemological beliefs dimension. See Tables 33 and 34 for results of these analyses.

Table 33

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Professors' Certainty of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*

Naïve (n = 31)	3.05	.56	2.09	.41	1.88	.42	2.70	.48	2.52	.64
Sophisticated (n = 51)	3.15	.63	2.26	.48	2.02	.38	2.78	.40	2.76	.57

Data from the SCEBS indicated that students whose professors were included in the naïve certainty of knowledge group reported more sophisticated epistemological beliefs than did their counterparts studying under those professors included in the sophisticated source of knowledge group in each of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS.

Table 34

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Professors' Certainty of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 31)	3.10	.55	2.10	.39	1.95	.38	2.64	.51	2.55	.64
Sophisticated (n = 51)	3.05	.60	2.13	.46	2.00	.44	2.76	.43	2.80	.61

Descriptive analysis of the SCEBS-2 data indicated that students of professors in the sophisticated source of knowledge group reported more sophisticated epistemological

beliefs in only one dimension—source of knowledge. Students of professors in the naïve source of knowledge group reported more sophisticated beliefs than did their counterparts in the remaining four dimensions—certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

The second MANCOVA was designed to determine whether a statistically significant difference existed between the epistemological beliefs development of those students whose professors reported sophisticated beliefs regarding the certainty of knowledge dimension and those students whose professors reported naïve beliefs regarding the certainty of knowledge dimension. Results indicated that no statistically significant differences existed between the development of the epistemological beliefs of students who studied under professors in the sophisticated certainty of knowledge group and that of students who studied under the professors included in the naïve certainty of knowledge group, after controlling for students' epistemological beliefs as measured by the SCEBS (pre-test). Only in the certainty of knowledge ($F_{(2, 90)} = 1.68, p = .191$) and speed of learning ($F_{(2, 90)} = 1.91, p = .153$) domains did the differences between groups of students' scores approach a statistically significant level. For more detailed results of this MANCOVA, see Table 35 below.

Table 35

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Certainty of Knowledge Group Membership

Dimension	Sig. (p)
Source	.376
Certainty	.191

Speed	.153
Structure	.827
Stability	.657

Next, the researcher conducted a descriptive analysis based on professors' group membership with relation to the speed of learning epistemological beliefs dimension. See Tables 36 and 37 for results of these analyses.

Table 36

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Professors' Speed of Learning Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 35)	3.09	.59	2.09	.42	1.97	.41	2.71	.45	2.62	.70
Sophisticated (n = 47)	3.13	.62	2.28	.48	1.96	.40	2.78	.42	2.71	.53

Data from the SCEBS indicated that students whose professors were included in the naïve speed of learning group reported more sophisticated epistemological beliefs than did their counterparts studying under those professors included in the sophisticated source of knowledge group in four of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS—source of knowledge, certainty of

knowledge, structure of knowledge, and stability of knowledge. Students whose professors were included in the sophisticated speed of learning group reported more sophisticated beliefs than their counterparts in the remaining dimension of speed of learning.

Table 37

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Professors' Speed of Learning Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 35)	3.12	.60	2.09	.38	1.98	.43	2.69	.52	2.67	.76
Sophisticated (n = 47)	3.03	.57	2.15	.47	1.98	.41	2.74	.41	2.73	.52

Descriptive analysis of the SCEBS-2 data indicated that students of professors in the sophisticated speed of learning group reported more sophisticated epistemological beliefs in only one dimension—source of knowledge. Students of professors in the naïve source of knowledge group reported more sophisticated beliefs than did their counterparts in three of the remaining four dimensions—certainty of knowledge, structure of knowledge, and stability of knowledge. Both student groups reported the same level of sophistication in their beliefs regarding the speed of learning dimension.

The second MANCOVA was designed to determine whether a statistically significant difference existed between the epistemological beliefs development of those students whose professors reported sophisticated beliefs regarding the speed of learning dimension and those students whose professors reported naïve beliefs regarding the speed of learning dimension. Results indicated that no statistically significant differences existed between the epistemological beliefs of students who studied under professors in the sophisticated speed of learning group and those of students who studied under the professors included in the naïve speed of learning group, after controlling for students' epistemological beliefs as measured by the SCEBS (pre-test). Only in the speed of learning domain did the differences between groups of students' scores approach a statistically significant level ($F_{(2, 90)} = 1.83, p = .166$). For more detailed results of this MANCOVA, see Table 38 below.

Table 38

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Speed of Learning Group Membership

Dimension	Sig. (*p*)
Source	.266
Certainty	.484
Speed	.166
Structure	.813
Stability	.724

Next, the researcher conducted a descriptive analysis based on professors' group membership with relation to the structure of knowledge epistemological beliefs dimension. See Tables 39 and 40 for results of these analyses.

Table 39

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Professors' Structure of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 28)	2.94	.57	2.06	.40	1.84	.39	2.64	.43	2.54	.51
Sophisticated (n = 54)	3.20	.61	2.27	.48	2.03	.39	2.81	.43	2.74	.64

Data from the SCEBS indicated that students whose professors were included in the naïve structure of knowledge group reported more sophisticated epistemological beliefs than did their counterparts studying under those professors included in the sophisticated structure of knowledge group in each of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS—source of knowledge, certainty of knowledge, speed of learning, structure of knowledge, and stability of knowledge.

Table 40

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Professors' Structure of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 28)	3.01	.56	2.08	.36	1.95	.38	2.60	.54	2.56	.64
Sophisticated (n = 54)	3.10	.59	2.15	.47	2.00	.44	2.77	.41	2.78	.62

Descriptive analysis of the SCEBS-2 data indicated that students of professors in the naïve structure of knowledge group again reported more sophisticated beliefs than did their counterparts in each of the five epistemological beliefs dimensions assessed in the EBI component of the SCEBS-2.

The fourth MANCOVA was designed to determine whether a statistically significant difference existed between the epistemological beliefs development of those students whose professors reported sophisticated beliefs regarding the structure of knowledge dimension and those students whose professors reported naïve beliefs regarding the structure of knowledge dimension. Results indicated that no statistically significant differences existed between the epistemological beliefs of students who studied under professors in the sophisticated structure of knowledge group and those of students who studied under the professors included in the naïve structure of knowledge group, after controlling for students' epistemological beliefs as measured by the SCEBS

(pre-test). Only in the speed of learning domain did the differences between groups of students' scores approach a statistically significant level ($F_{(2, 90)} = 2.01, p = .140$). For more detailed results of this MANCOVA, see Table 41 below.

Table 41

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Structure of Knowledge Group Membership

Dimension	Sig. (*p*)
Source	.521
Certainty	.316
Speed	.140
Structure	.805
Stability	.644

Next, the researcher conducted a descriptive analysis based on professors' group membership with relation to the structure of knowledge epistemological beliefs dimension. See Tables 42 and 43 for results of these analyses.

Table 42

Descriptive Statistics for Students' SCEBS Epistemological Beliefs According to Professors' Stability of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve	3.17	.63	2.25	.41	1.99	.38	2.78	.39	2.65	.54

(n = 36)										
Sophisticated (n = 46)	3.07	.59	2.15	.50	1.94	.42	2.73	.47	2.69	.66

Data from the SCEBS indicated that students whose professors were included in the naïve stability of knowledge group reported more sophisticated epistemological beliefs than did their counterparts studying under those professors included in the sophisticated stability of knowledge group in only one of the five epistemological beliefs dimensions measured by the EBI component of the SCEBS—stability of knowledge. Students who received instruction from professors included in the sophisticated stability of knowledge group reported more sophisticated beliefs than did their counterparts in the remaining four epistemological beliefs dimensions—source of knowledge, certainty of knowledge, speed of learning, and structure of knowledge.

Table 43

Descriptive Statistics for Students' SCEBS-2 Epistemological Beliefs According to Professors' Stability of Knowledge Group Membership

Group	Dimension									
	Source		Certainty		Speed		Structure		Stability	
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*
Naïve (n = 36)	3.13	.53	2.15	.43	1.98	.45	2.74	.47	2.74	.69
Sophisticated (n = 46)	3.03	.62	2.11	.44	1.98	.40	2.70	.46	2.68	.59

Descriptive analysis of the SCEBS-2 data indicated that students of professors in the sophisticated stability of knowledge group reported more sophisticated beliefs than did their counterparts in four of the five epistemological beliefs dimensions assessed in the EBI component of the SCEBS-2—source of knowledge, certainty of knowledge, structure of knowledge, and stability of knowledge. In the speed of learning dimension, both groups' scores were found to be nearly the same.

The fifth and final MANCOVA associated with this series of analyses was designed to determine whether a statistically significant difference existed between the epistemological beliefs development of those students whose professors reported sophisticated beliefs regarding the stability of knowledge dimension and those students whose professors reported naïve beliefs regarding the stability of knowledge dimension.

Results indicated that no statistically significant differences existed between the epistemological beliefs of students who studied under professors in the sophisticated stability of knowledge group and those of students who studied under the professors included in the naïve stability of knowledge group, after controlling for students' epistemological beliefs as measured by the SCEBS (pre-test). Only in the speed of learning domain did the differences between groups of students' scores approach a statistically significant level ($F_{(2, 90)} = 1.84, p = .165$). For more detailed results of this MANCOVA, see Table 44 below.

Table 44

MANCOVA Results for Epistemological Beliefs (SCEBS-2) According to Instructors' Stability of Knowledge Group Membership

Dimension	Sig. (p)
Source	.691
Certainty	.937
Speed	.165
Structure	.864
Stability	.466

CHAPTER FIVE

DISCUSSION

Discussion of Major Findings

The following section includes discussions and interpretations regarding the major findings that resulted from the analyses described in the previous chapter. Subsections will be devoted to findings related to each component of each of the three research questions posed at the outset of this study. Relationships between study findings and those identified by other scholars are also included and interpreted.

Student Beliefs and Demographic and Academic Characteristics

The following three sections explain several of the most consequential findings related to this study's first research question: What is the relationship between teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics?

Student beliefs and gender. The current study did not identify any statistically significant differences between the epistemological beliefs (as measured by SCEBS) of females and those of males. As such, the following discussion is based on differences that, while not statistically significant, are noteworthy and potentially valuable nevertheless. First, in each of the five epistemological beliefs categories, females reported more sophisticated beliefs than did their male counterparts. Casting doubt on the value of this finding is the fact that, as the current study was conducted within the context of an education/teacher training program that is populated largely by females, the number of male participants was markedly smaller than the number of female

participants. It is possible that, given a larger sample of males, findings could have been different. Still, the finding, if true, lends some credence to the idea that females may experience an epistemological beliefs "growth spurt" at a younger age than do their male counterparts. Wood (1993) asserted this possibility, and the current study's findings provide that assertion with some support, inconclusive though it is.

On the other hand, when students were divided by educational level (i.e., separated into subgroups according to whether they were undergraduate or graduate students), descriptive statistics indicated that undergraduate males reported more sophisticated beliefs than did their female peers. Females outstripped males only among the graduate student participants. This finding seems to contradict Wood's (1993) assertion about the timing of the two genders' epistemological "growth spurts."

Student beliefs and ethnicity. Study findings did not indicate any statistically significant differences between the epistemological beliefs of students who self-identified as one or another ethnicity. While the participating Asian/Pacific Islander students reported the most sophisticated epistemological beliefs within four of the five epistemological beliefs dimensions (all except certainty of knowledge), this group was under-represented within the current study's sample, so these findings should be subjected to skeptical consideration—first because of the small sample size, and second because the minor differences between groups were not statistically significant.

Interestingly, while Native American participants reported the least sophisticated epistemological beliefs in several dimensions, they reported the most sophisticated beliefs in the certainty of knowledge dimension. This finding, though it was not statistically significant and though it was based on an extremely small sample of Native

Americans (n = 2), provides modest support for Schommer's (1994) inconclusive stance that, while there is almost certainly a relationship between ethnicity and epistemological beliefs, this relationship remains, for now, unclear.

Student beliefs and age. In the study's analysis of the relationship between participating students' age and their epistemological beliefs, no statistically significant differences were identified between the students' age groups' beliefs. Findings indicated that the 35-39-year-old participants reported the most sophisticated epistemological beliefs within the source of knowledge dimension, while their youngest counterparts (i.e., those aged 19 years or less) reported the least sophisticated beliefs in this dimension. This finding seems to lend credence to the belief espoused by King & Kitchener (1981) that individuals' epistemological beliefs naturally become more sophisticated as they age. However, it should be mentioned that, within the certainty of knowledge dimension, while 35-39-year-olds again reported the most sophisticated beliefs, this time it was the oldest participants—those aged 45 years or more—who reported the least sophisticated beliefs. This finding suggests the possibility that individuals may not progress in an orderly, linear fashion from naïve to sophisticated epistemological beliefs throughout their lives. Perry (1968) may have been the first to explicitly suggest the possibility that individuals may revert back to naive epistemological beliefs, but King and colleagues (1983) claimed that once an individual adopted a more sophisticated epistemological belief, that individual would never regress to the naïve position s/he left behind. While this study cannot confirm that its older participants once held more sophisticated beliefs and have now reverted back to previously held, naïve views, this finding does point to the

need to question the assumption that epistemological beliefs become increasingly sophisticated as an individual ages.

Next, within the stability of knowledge dimension, the youngest students (i.e., those 19 years old or younger) reported more sophisticated beliefs than did any of the other age groups included in the study. In addition to challenging the assumption that older people possess more sophisticated epistemological beliefs than do younger people (e.g., King & Kitchener, 2002) and supporting the notion that individuals do not necessarily progress from naïve to sophisticated on all epistemological beliefs dimensions at the same rate (Schommer, 1990), this finding prompts the researcher to wonder whether technological advances or other social changes may be impacting beliefs related to the stability of knowledge. Specifically, in a world in which "truth" is defined and redefined over and over on sites such as Wikipedia, could it be possible that young people's perceptions regarding the stability of knowledge are fundamentally different that those beliefs within people of older generations? This sort of question will be discussed further later in this chapter.

Student beliefs and academic experience. The researcher sought to determine whether differences existed between the epistemological beliefs of students who had completed different levels of education—high school, two years of undergraduate study, a bachelor's degree, and a master's degree. The preliminary MANOVA analysis failed to indicate statistically significant differences between the SCEBS (pre-test) epistemological beliefs of these groups of students. Interestingly, though, within the stability of knowledge domain, those students with two years of undergraduate experience reported the most sophisticated epistemological beliefs, while the students who had only

completed high school reported the least sophisticated beliefs. This finding speaks directly to the point alluded to earlier—that the impact of the entire college experience on students' epistemological beliefs may well be profound (Kardash & Howell, 2000) and, thus, should be explored systematically by comparing college students' epistemological beliefs to those of individuals not participating in collegiate study.

Next, students who had completed a master's degree reported the most sophisticated epistemological beliefs in several dimensions—source of knowledge, certainty of knowledge, and structure of knowledge. This finding is consistent with Kardash & Howell's (2000) and Perry's (1968) belief that collegiate study supports students' development of sophisticated epistemological beliefs.

Findings related to this particular part of the study provide additional support for Schommer's (1990) notion that the level of sophistication of students' beliefs in one epistemological beliefs dimension may not be reflected in the same students' beliefs in another dimension.

Student beliefs and prospective teaching grade level. No statistically significant differences were identified between the epistemological beliefs of the groups of participating students planning to teach different grade levels of students. Nevertheless, the fact that students planning to teach early childhood grade levels reported the most sophisticated epistemological beliefs in some dimensions, while students planning to teach secondary grade levels reported the most sophisticated beliefs in another dimension is interesting. Clearly, this finding supports Schommer's (1990) claim that an individual's beliefs need not develop in each dimension according to the same schedule. Additionally, the finding prompts the researcher to wonder what specific

facets of the experiences of these two groups led them to such different epistemological beliefs. Perhaps something about the contexts in which these individuals studied led them to develop differential beliefs. Such a conclusion would support the belief held by scholars including Bromme, Kienhues, & Stahl (2008) and Buehl, Alexander, & Murphy (2002) that each individual possesses some epistemological beliefs that are context-specific—that is, beliefs that change according to one's environment.

Student beliefs and prospective teaching content area. Analysis of the differences in the epistemological beliefs of groups of students planning to teach different content areas was particularly interesting. While it was formerly assumed by Perry (1968) and other early epistemological beliefs researchers that one's epistemological beliefs were domain-independent (that is, that beliefs were developed independently of one's major field of study), it is now widely believed (e.g., Muis, Bendixen, & Haerle, 2006) that students' major fields of study may differentially impact their epistemological beliefs. As students participating in this study provided the researcher with information about the fields in which they plan to teach, they implicitly provided the researcher with information about the subjects they spend the most time studying in college. This is true because, in traditional teacher preparation programs, in order for a teacher to be licensed to practice in Virginia, that teacher must complete a bachelor's degree program in the content area in which she plans to teach. Based on this information, the researcher was curious about the impacts these different courses of study would have on participants' epistemological beliefs at the study's outset (SCEBS) and throughout the course of the study (SCEBS-2).

Differences between the groups of students' beliefs as measured by SCEBS indicated statistically significant differences in the speed of learning epistemological beliefs dimension. Specifically, prospective English teachers reported statistically significantly more sophisticated beliefs in this dimension than did their counterparts not planning to teach. This finding aligns well with Paulsen and Wells' (1998) findings that students in "pure" fields (as defined by Biglan [1973]) tend to possess more sophisticated beliefs than do their counterparts studying in "applied" fields.

Additionally, prospective math teachers reported statistically significantly more sophisticated beliefs than did their counterparts planning to teach social studies as well as those teachers planning to teach in special education and those participants who indicated that they planned not to teach. Next, students planning to teach in "other" content areas reported statistically significantly more sophisticated beliefs than did their peers planning to teach social studies as well as those peers not planning to teach. This finding, too, indicates support for Jehng et al.'s findings related to individuals studying in "pure" fields.

The general fact that the groups of teachers planning to teach in different content areas reported markedly different epistemological beliefs supports Jehng and colleagues' (1993) assertion that students studying within different major fields may well possess different epistemological beliefs. However, the fact that all participating students were involved in studies of what Biglan (1973) called the "applied" field of education as well as their major courses of study renders it difficult for the researcher to isolate the epistemological beliefs that resulted from studies within the education field apart from those resultant from students' major fields of study. As King & Kitchener (2002) note, it

is possible that sophisticated epistemological beliefs may be developed within the contexts of fields in which students are engaged deeply and that these sophisticated beliefs eventually spread to other domains in which students are not so deeply engaged.

Finally, prospective social studies teachers reported the most sophisticated beliefs in one dimension of epistemological beliefs, while these same prospective teachers reported the least sophisticated beliefs in two other dimensions. This fact provides further support for Schommer's (1990) claim that the sophistication of one's beliefs in one dimension may not be reflected evenly in their beliefs with relation to other epistemological beliefs dimensions.

Student Beliefs Development and Demographic and Academic Characteristics

The following three sections explore some of the more salient findings pertaining to this study's second research question: What is the relationship between the development of teacher education students' epistemological beliefs and their demographic (gender, ethnicity and age) and academic (prior academic experience, prospective teaching content area and prospective teaching grade level) characteristics?

Development and gender. When a MANCOVA was conducted in order to control for students' SCEBS (pre-test) epistemological beliefs, the researcher did identify a statistically significant difference between the epistemological development of the two genders of participating students within the certainty of knowledge dimension during the course of the study. While females initially reported more sophisticated beliefs in this dimension, their male peers reported statistically significantly more sophisticated beliefs on the SCEBS-2 (post-test). This finding provides what is perhaps the current study's most salient contribution to the body of knowledge on the relationship between gender

and epistemological beliefs in that this finding directly supports Wood's (1993) assertion that, while females may experience an epistemological growth spurt in high school (or perhaps earlier), an analogous spurt occurs during collegiate study among males.

Further, it seems interesting that, while males developed more sophisticated epistemological beliefs in each of the five epistemological beliefs dimension than did their female counterparts, only one of these development differences was statistically significant. This finding points to the now commonly held belief originally advanced by Schommer (1990) that epistemological beliefs are multidimensional and that individuals may progress from naïve to sophisticated positions within each of these dimensions at different rates. In this chapter's subsequent sections it will become clear that this theme was repeatedly evidenced within the current study's findings.

Development and ethnicity. Study findings did not indicate any statistically significant differences between the epistemological beliefs development of students who self-identified as one or another ethnicity. However, though differences between the two groups' development were not statistically significant, African Americans' epistemological beliefs developed more during the course of the study, in the contexts of the courses in which these students were enrolled, than did those of their Caucasian peers. This finding is interesting and potentially important, but the fact that this finding does not come along with an explanation lends credence to the "murky" (Schommer, 1994, p. 314) nature of the connection between culture and epistemological beliefs.

Development and age. When students' epistemological development was assessed through MANCOVA procedures, no statistically significant differences between age groups were identified, but analysis of group differences within the stability of

knowledge dimension indicated a nearly statistically significant difference between groups' development. While the youngest participants began the study with the most sophisticated beliefs in this dimension, several groups of older participants reported more sophisticated beliefs in this dimension on the SCEBS-2, possibly pointing to King & Kitchener's (1981) claim that people develop more sophisticated beliefs as they age.

However, this finding casts additional light on the need for epistemological beliefs research that includes individuals not participating in collegiate study. Such studies would help the research community better determine whether epistemological beliefs develop naturally, over time, or if they only develop in response to collegiate study or the collegiate environment, in general. This idea, too, will be further developed later in this chapter.

Development and academic experience. When MANCOVA procedures were employed in order to determine the extent to which groups developed differently during the study, no statistically significant differences were identified, but students who had completed only high school were found to possess the most sophisticated epistemological beliefs at the time of SCEBS-2 implementation. This finding, though not statistically significant, does challenge scholars like Kardash & Howell (2000) who would likely expect students with more education to consistently espouse more sophisticated epistemological beliefs than their more junior peers.

Development and prospective teaching grade level. When students' beliefs were analyzed using MANCOVA procedures to isolate the epistemological changes that occurred during the course of the study, the researcher did not identify any statistically significant differences between the groups of students planning to teach in different grade

levels. These findings lend support to the null hypothesis—that is, that no statistically significant differences exist between the epistemological beliefs development of groups of preservice teachers planning to teach in different grade levels.

Interestingly, those student who were enrolled in teacher education courses but who did not plan to teach experienced the least epistemological development of all the student groups in the sample, in each of the five epistemological beliefs dimensions. This finding, though not attached to statistically significant differences, may provide support for Bendixen & Rule's (2004) beliefs regarding epistemic volition. These scholars believe that, even in contexts in which students are faced with epistemic doubt, unless these students experience epistemic volition (i.e., the ability to focus on a task in the face of distractions) as well, their epistemological beliefs may not develop. Perhaps the students engaged in teacher education courses were distracted from epistemological development by the fact that they were not planning to put into practice the content they were learning. As King & Kitchener (2002) note, students' epistemological beliefs may become more sophisticated first in fields in which students are deeply engaged.

Development and prospective teaching content area. When students' beliefs were analyzed using MANCOVA procedures to isolate the epistemological changes that occurred during the course of the study, the researcher did not identify any statistically significant differences. Interestingly, while prospective social studies teachers' beliefs developed the least in the stability of knowledge dimension, these same students' beliefs developed the most in the certainty of knowledge epistemological beliefs dimension. This finding, though not attached to statistically significant differences, does provide further evidence to support Schommer's (1990) now widely held belief that

epistemological beliefs are not a homogeneous set of beliefs developing in tandem but are, rather, beliefs on a number of independent continua and that the sophistication of an individual's beliefs on one continuum may not reflect that same individual's beliefs on another continuum.

Student Beliefs Development and Course Characteristics

The following three sections explore some of the more salient findings pertaining to this study's third research question: What is the relationship between the development of teacher education students' epistemological beliefs and the characteristics (course delivery methodology, epistemological beliefs-oriented instructional strategies employed by the professors, and professors' epistemological beliefs) of the classes in which they are enrolled during the study?

Student beliefs development and course delivery methodology. Comparisons were made between the epistemological beliefs of students enrolled in courses delivered differently. Specifically, comparisons were made between students who were enrolled in participating courses delivered face-to-face (traditional college courses), distance learning courses in which students attended class meetings that were broadcast from one teaching site, distance learning courses in which students watched class broadcasts from their homes, and distance learning courses that were completely web-based and did not include any formal class meetings.

Interestingly, at the time of SCEBS administration (pre-test), students enrolled in distance learning, synchronous classes (those classes in which students attend class meetings that are broadcast from one site) reported the most sophisticated epistemological beliefs in four of the five epistemological beliefs dimensions. In one

epistemological beliefs dimension, students in face-to-face classes reported the least sophisticated beliefs, while their peers enrolled in web-based classes reported the least sophisticated beliefs in two more epistemological beliefs dimensions. None of the available epistemological beliefs literature provided the researcher with likely explanations for this phenomenon, but it could be that there is some relationship between students' epistemological beliefs and the types of delivery methodologies they choose. It could also be the case that students' scheduling requirements made it necessary for them to select the delivery methodologies they did and that epistemological beliefs played no role in their selection process. Either way, this is an issue worthy of further exploration, and it will be discussed later in this chapter.

When MANCOVA procedures were employed to isolate the development of participants' epistemological beliefs during the course of the study according to the delivery methodology of the participating course in which they were enrolled, statistically significant differences were identified within the source of knowledge and speed of learning epistemological beliefs dimensions. Within the source of knowledge dimension, students enrolled in distance learning courses in which they attended classes broadcast from one site reported the development of more sophisticated epistemological beliefs than did their counterparts in video streaming sections, web-based courses, and in face-to-face sections.

The latter contrast was the most interesting to the researcher, because it flew in the face of the researcher's expectations. Based on Brownlee's (2004) assertion that instructional strategies like Relational Pedagogy/Connected Teaching can only help individuals develop more sophisticated beliefs if "an atmosphere of care and trust" is

fostered within the classroom community (p. 5), the researcher expected those students who took face-to-face classes to experience heightened epistemological beliefs development during the course of the study simply because of the enhanced opportunities these students would have to interact meaningfully with their classmates and instructor. Within the source of knowledge dimension, distance learning, synchronous students again reported the most sophisticated level of epistemological beliefs development during the course of the study. While it is possible that participation in courses delivered in different ways might differentially impact students' epistemological beliefs, it is likewise possible that students' epistemological beliefs predispose them to the selection of particular course delivery methodologies. However, it must be noted that, with regard to the latter explanation, the factors contributing to such predisposition remain unexplored. Clearly, to echo Kelly, Ponton, & Rovai (2007), further research needs to be conducted on the impacts of course delivery methodologies, in general, as well as studies geared specifically toward identifying relationships between epistemological beliefs development and course delivery methodologies.

Also within the speed of learning dimension, students enrolled in face-to-face course sections reported more sophisticated epistemological beliefs development than did their counterparts in web-based courses. While epistemological beliefs researchers have yet to substantively explore the relationships between course delivery methodologies and students' epistemological beliefs, the mixed nature of this study's findings aligns well with the mixed findings reported in the popular meta-analyses comparing online and traditional instruction. Jagger & Bailer (2010) reported that traditional, face-to-face instruction produces slightly better learning outcomes, while the US DOE (2009)

reported that students in online courses learned more than did their counterparts in traditional classrooms. Essentially, the current study echoes the claim that more work needs to be done in order to determine the various impacts associated with different course delivery methodologies, especially those impacts dealing directly with epistemological beliefs.

Student beliefs development and instructional strategies. The researcher also explored the relationship between students' epistemological beliefs development and their professors' use or non-use of instructional strategies designed to impacts students' epistemological beliefs in order to address King & Kitchener's (2002) and Pintrich's (1997) point that researchers should seek to connect individuals' pedagogical experiences to their epistemological beliefs. Participating instructors were asked in SCEBS-2 to indicate whether or not they designed instruction aimed at impacting their students' epistemological beliefs, and the instructors were then divided into two groups according to their responses.

While MANCOVA procedures controlling for students' SCEBS (pre-test) beliefs in order to isolate their epistemological development failed to identify statistically significant differences between groups of students' beliefs, differences between the two groups' scores in two dimensions (structure of knowledge and stability of knowledge) approached statistically significant levels. In both these cases, students of instructors who attempted to impact their students' epistemological beliefs reported the development of more sophisticated epistemological beliefs than did their counterparts who studied under professors who did not report attempting to impact students' epistemological beliefs.

Though the number of professors who did not report attempting to impact their students' epistemological beliefs was notably smaller than the number who did report attempts to impact students' beliefs, the fact that any professors were included in the former group lends credence to Brownlee's (2004) point that teacher education, at times, fails to focus on students' epistemological beliefs. These findings also echo those of Kienhues and colleagues (2008) who reported that, while some domain-independent epistemological beliefs are likely resistant against short-term interventions, instructors' attempts to develop their students' beliefs can be successful in terms of other, domain-specific epistemological beliefs. Essentially, the current study's findings provide substantial support for Boden and colleagues' (2005-2006) claim that educators should continue working to develop curricula designed to help students develop more sophisticated epistemological beliefs.

Further, instructors who reported attempts to impact their students' epistemological beliefs were asked to indicate whether their attempts were explicit (i.e., whether they explained epistemological beliefs to their students and explained that the instruction was designed to impact students' beliefs) or implicit. Though literature in this field (e.g., Baxter Magolda, 1993b; Allen, 1991) suggests that instructors who delivered explicit epistemological beliefs instruction would allow students more epistemological development than would their colleagues delivering implicit epistemology instruction, no statistically significant differences were identified between the epistemological beliefs development of the students of professors providing explicit epistemological instruction and those of students whose professors provided implicit epistemological beliefs instruction. It could be that, as Beers (1988) found, students whose instructors provide

effective implicit epistemological beliefs instruction experience the same level of growth as do their counterparts receiving explicit epistemological beliefs instruction. In other words, students may develop more sophisticated beliefs whether or not they are told to expect this growth.

Student beliefs development and instructors' beliefs. In the ISEBS, participating instructors reported their own epistemological beliefs, and these data allowed the researcher to divide the instructors into groups according to the relative sophistication of their epistemological beliefs in each of the five dimensions. Though this process included important limitations that will be discussed below, instructors were grouped, and MANCOVAs were conducted in order to determine whether students of epistemologically sophisticated instructors developed differently than did their peers studying under epistemologically naïve professors. These analyses, flawed though they were, represented this researcher's attempt to address one of the major areas of need within the field of epistemological beliefs research—identifying what Hofer and Pintrich (1997) called "the intersection of teachers' epistemological theories and those of students" (p. 124). Instructors' beliefs may well be important factors impacting their students' beliefs for, as Schommer (1994) notes, "The issue of what influences epistemological beliefs is murky at best" (p. 314).

Within the source of knowledge dimension, after controlling for students' preliminary epistemological beliefs (SCEBS), no statistically significant differences were identified between the epistemological beliefs of those students of professors who were naïve in terms of source of knowledge and the beliefs of students of professors who were sophisticated in that dimension. However, in the source of knowledge dimension,

students' SCEBS beliefs indicated that, at the beginning of the semester during which the study was conducted, students of naïve source of knowledge professors possessed more sophisticated beliefs in this dimension, but at the end of the study (SCEBS-2), students of professors in the sophisticated group reported more sophisticated beliefs than did their peers. This finding supports the intuitive notion asserted by Arrendolo and Rucinski (1996), Hashweh (1996), White (2000), and Brownlee (2001; 2003) that epistemologically sophisticated professors might be better able than their less epistemologically sophisticated peers to run classrooms conducive to students' epistemological development.

At the same time, though, it must be noted that, when professors were grouped according the source of knowledge dimension, students' beliefs in the source of knowledge dimension actually grew less among those students in the sophisticated professor group than did the beliefs of those students in the naïve professor group. The same trend that emerged when professors were divided according to their beliefs in the source of knowledge dimension was repeated when professors were grouped in the remaining four dimensions. In other words, sophisticated professors at times allowed their students to develop more sophisticated beliefs than did their peers in classes taught by naïve professors, but at other times, naïve instructors' students developed more sophisticated beliefs than did their peers studying under sophisticated professors. In no instances were there statistically significant differences between these groups' epistemological beliefs development. These findings, inconclusive though they are, point to the "murky" connection that Schommer (1994) identified between influencing factors and students' beliefs.

Limitations

Perhaps the most notable limitation associated with the current study dealt with sample size. While the study included approximately 20 instructors and more than 200 students, when these students were separated into groups according to their status with relation to many of the independent variables included in the analyses described above, subgroup sizes were often small. In some cases, this limitation rendered it impossible for the researcher to conduct analytic procedures necessary to identify statistically significant differences between groups. As such, the study was not able to meet its full potential. Additionally, in other cases, statistical procedures were conducted with samples that diminish the trustworthiness of results. Also related to this study's participants is the internal validity threat known as selection bias. Students chose to participate or not to participate for unknown, probably varied reasons. This fact means that the students who chose to participate in the current study may not be fully representative of the population from which this sample was drawn. Those who design future studies based on this study's findings should not underestimate the seriousness of this limitation and should take great care to assure that findings drawn from small samples should be met with healthy skepticism.

Another "big picture" threat to the internal validity of this study's findings is associated with the fact that all data collection measured implemented in the current study relied solely on self-report data. While these self-report measures were necessary in order for the researcher to include the large number of participants desired for the current study, self-report data comes along with all sorts of problems, especially in terms of social desirability bias. Both professors and students who participated in the study

may have answered dishonestly, according to what they thought they ought to believe rather than what they actually believed. As is the case with the sample size problem discussed above, subsequent studies should recognize this limitation as a serious one and exercise caution when evaluating the validity of the findings described above.

An additional internal validity threat also dealing with instrumentation has to do with the quantitative nature of the EBI component of both the SCEBS and the SCEBS-2. Scholars like Perry (1968) and Baxter Magolda (e.g., 2004) believed that qualitative studies that rely on semi-structured or unstructured, conversational interviews provide researchers with a much better understanding of students' beliefs than do quantitative studies, in general. These scholars believe quantitative measure to be overly general and too limiting to provide researchers with accurate understandings of their participants' actual beliefs. Similarly, Baxter Magolda (e.g., 1970) has relied heavily on longitudinal studies that measure the same individuals' epistemological beliefs across years and, in some cases, decades. Studies like these provide the researchers with a long-view of individuals' epistemological beliefs development rather than relying on "snapshots" resulting from short-term studies like the current study. Based on this criticism, scholars should be wary of having too much faith in the depictions of this study's participants' development over the course of just a few months.

Next, many of the students who participated in the current study were simultaneously enrolled in many courses—not just those participating in the study. As such, it may not be fair to attribute changes in these students' epistemological beliefs solely to the characteristics of the participating courses in which they were enrolled.

In addition to the numerous and varied courses in which students were enrolled, it is also likely that non-academic influences impacted participating students' epistemological beliefs during the course of the study. Pai's (1990) findings indicate that students' cultural backgrounds may be salient influences on their epistemological beliefs and that these influences may overshadow those of formal educational experiences. As Schommer (1993b) implied, these outside-the-classroom influences are not well understood, but their impacts should not be underestimated.

Additionally, the study's analysis of the relationship between the development of students' beliefs and the relative sophistication of their instructors' epistemological beliefs included another important internal validity threat. Since the instructors all tended toward the sophisticated end of each of the epistemological belief spectra, organizing them into naïve/sophisticated groups could be considered artificial and unfair, akin to regarding a student who earned a 99% as a poor student with relation to another student who earned a 100%. In this case, both students did an effective job. When this simile is extended to the current study, it seems likely that both the relatively sophisticated and the relatively naïve professors possessed sufficiently sophisticated epistemological beliefs to impact their students' beliefs, given these professors' absolute positions on the epistemological beliefs continua associated with each individual dimension.

In terms of external validity, this study's findings are also seriously limited in terms of population validity. Here, it is important to refer again to the fact that the current study's participants included only students and professors within the Darden College of Education in Old Dominion University. Conclusions drawn from this sample should not be assumed to apply to students or professors in other colleges within Old

Dominion University. Neither should these findings be assumed to apply to students or professors within any other universities' colleges of education.

Directions for Further Inquiry

While the current study took important strides toward filling conspicuous gaps in epistemological beliefs research literature, the researcher is aware that the study's findings draw more attention to the gaps that remain un- or under-explored. Several of these gaps are addressed in this, the study's final section.

Subsequent studies should seek to flesh out the relationship between students' epistemological beliefs and their cultural backgrounds and ideals. The varying, inconclusive relationships that were observed between students' beliefs and their statuses with relation to demographic and academic characteristics assessed in this study makes it clear that other variables must exert important influences on individuals' epistemological beliefs. As Baxter Magolda (2004) notes, studies that are qualitative, longitudinal, and geared toward the establishment of deep, meaningful relationships between researchers and participants seem likely to provide researchers with fruitful information regarding the deeply personal cultural elements that seem to be important epistemological influences.

Next, subsequent studies should seek to extend epistemological beliefs research beyond the college walls. As the research community's understanding of epistemological beliefs expands, so, too, should the range of participants included in epistemological beliefs studies. While access to non-college samples is problematic, researchers should take whatever steps are necessary in order to help better understand what epistemological beliefs development can be attributed to collegiate study and what developments occur as a function of age, independent of formal educational experiences. If one believes that

epistemological beliefs are important for all people, then studies focusing only on the subset of people engaged in collegiate study can only, at their best, provide scholars with a partial understanding of the larger issue at play.

Subsequent studies should also address the relationship between the epistemological beliefs of teacher education students and those of students of other disciplines. As was mentioned above, the current study included only students with one college of education, so objective comparisons between students of other disciplines was absent. Such comparisons may allow researchers to better differentiate between domain-specific and domain-independent beliefs, as well as providing researchers with information needed to begin clarifying the relationship between beliefs and influencing factors.

Future studies, including one already underway, should seek to further explore the connection between course delivery methodologies and students' epistemological beliefs. The varied nature of the current study's findings with relation to this issue points to the fact that little is yet known about the ways in which different course delivery methodologies interact with students' epistemological beliefs. As distance education and other non-traditional delivery platforms increase in prevalence, it is vital for all those who believe in the important of epistemological beliefs to begin coming to a more effective understanding not just of the ways in which different delivery methodologies interact with students' beliefs, but of the course features and instructional strategies that instructors can bring to bear in order to make best use of the delivery methodologies they employ.

Similarly, as internet technology continues to permeate society, epistemological beliefs researchers should begin exploring the ways in which this new climate interacts with individuals' epistemological beliefs. As was noted above, it seems likely that today's Wikipedia world implicitly encourages individuals to adopt more sophisticated epistemological beliefs—especially in terms of epistemological beliefs dimensions like source of knowledge, certainty of knowledge, and stability of knowledge. If this is the case, researchers could provide educators with a ready-made suite of tools on the web that may help students to develop sophisticated epistemological beliefs. Likewise, understanding the epistemological influences of students' interactions with technological tools could help teachers develop a better understanding of instructional components that should be avoided.

Finally, the current study made it clear that further research is needed in order to develop epistemological beliefs instruments that allow researchers to leverage the efficiency of quantitative, self-report instruments while capitalizing on more of the strengths of qualitative instruments.

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Appendix A

EPISTEMOLOGICAL BELIEFS INVENTORY (EBI)

	Strongly Disagree				Strongly Agree
	1	2	3	4	5
1. It bothers me when instructors don't tell students the answers to complicated problems.					
2. Truth means different things to different people.					
3. Students who learn things quickly are the most successful.					
4. People should always obey the law.					
5. Some people will never be smart no matter how hard they work.					
6. Absolute moral truth does not exist.					
7. Parents should teach their children all there is to know about life.					
8. Really smart students don't have to work as hard to do well in school.					
9. If a person tries too hard to understand a problem, they will most likely end up being confused.					
10. Too many theories just complicate things.					
11. The best ideas are often the most simple.					
12. People can't do too much about how smart they are.					
13. Instructors should focus on facts instead of theories.					
14. I like teachers who present several competing theories and let their students decide which is best.					
15. How well you do in school depends on how smart					

you are.					
16. If you don't learn something quickly, you won't ever learn it.					
17. Some people just have a knack for learning and others don't.					
18. Things are simpler than most professors would have you believe.					
19. If two people are arguing about something, at least one of them must be wrong.					
20. Children should be allowed to question their parents' authority.					
21. If you haven't understood a chapter the first time through, going back over it won't help.					
22. Science is easy to understand because it contains so many facts.					
23. The moral rules I live by apply to everyone.					
24. The more you know about a topic, the more there is to know.					
25. What is true today will be true tomorrow.					
26. Smart people are born that way.					
27. When someone in authority tells me what to do, I usually do it.					
28. People who question authority are troublemakers.					
29. Working on a problem with no quick solution is a waste of time.					
30. You can study something for years and still not really understand it.					
31. Sometimes there are no right answers to life's big problems.					
32. Some people are born					

with special gifts and talents.					

Appendix B

STUDENT CHARACTERISTICS AND EPISTEMOLOGICAL BELIEFS SURVEY (SCEBS)

Instructions: Please respond carefully and honestly to each of the following items.

Part I. General Information

1. What is your **University Identification Number** (UIN)? (This number can be found on your Old Dominion University ID card.)

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2. In what **course** (TLED 301, for instance), were you invited to participate in this study?

Part II. Demographic Information

1. What is your **age**?
a. 19 years or younger
b. 20-24 years
c. 25-29 years
d. 30-34 years
e. 35-39 years
f. 40-44 years
g. 45 years or older

2. What is your **ethnicity**?
a. African American
b. Asian/Pacific Islander
c. Caucasian
d. Hispanic
e. Native American
f. Other

3. What is your **gender**?
a. Female
b. Male

4. What is the highest **level of education** you have **completed**?
a. High School
b. Two years undergraduate coursework (or equivalent)
c. Bachelor's Degree

d. Master's Degree
e. Doctoral Degree

5. What **grade level(s)** are you planning to teach/currently teaching?
a. Early Childhood (PreK-3)
b. PreK-6
c. Secondary

6. What **subject(s)/content area(s)** are you planning to teach/currently teaching? (Select all that apply.)
a. English/Language Arts
b. Social Studies
c. Science
d. Mathematics
e. Physical Education/Health
f. Foreign Language
g. Other

Part III. Epistemological Beliefs Inventory

	Strongly Disagree				Strongly Agree
	1	2	3	4	5
7. It bothers me when instructors don't tell students the answers to complicated problems.					
8. Truth means different things to different people.					
9. Students who learn things quickly are the most successful.					
10. People should always obey the law.					
11. Some people will never be smart no matter how hard they work.					
12. Absolute moral truth does not exist.					
13. Parents should teach their children all there is to know about life.					
14. Really smart students don't have to work as hard to do well in school.					

15. If a person tries too hard to understand a problem, they will most likely end up being confused.					
16. Too many theories just complicate things.					
17. The best ideas are often the most simple.					
18. People can't do too much about how smart they are.					
19. Instructors should focus on facts instead of theories.					
20. I like teachers who present several competing theories and let their students decide which is best.					
21. How well you do in school depends on how smart you are.					
22. If you don't learn something quickly, you won't ever learn it.					
23. Some people just have a knack for learning and others don't.					
24. Things are simpler than most professors would have you believe.					
25. If two people are arguing about something, at least one of them must be wrong.					
26. Children should be allowed to question their parents' authority.					
27. If you haven't understood a chapter the first time through, going back over it won't help.					
28. Science is easy to understand because it contains so many facts.					
29. The moral rules I live by apply to everyone.					
30. The more you know about a topic, the more there is to know.					
31. What is true today will be					

true tomorrow.					
32. Smart people are born that way.					
33. When someone in authority tells me what to do, I usually do it.					
34. People who question authority are troublemakers.					
35. Working on a problem with no quick solution is a waste of time.					
36. You can study something for years and still not really understand it.					
37. Sometimes there are no right answers to life's big problems.					
38. Some people are born with special gifts and talents.					

Appendix C

STUDENT CHARACTERISTICS AND EPISTEMOLOGICAL BELIEFS SURVEY—PART TWO (SCEBS-2)

1. Epistemological beliefs are your beliefs about the nature of knowledge and the ways in which knowledge is acquired. Not everyone has the same epistemological beliefs. For instance, some people believe that knowledge can only come from "authorities," while others believe that true knowledge can come from anyone—not just "authorities." Likewise, some people believe that learning occurs quickly or not at all, while others believe that with enough effort and time, people can learn anything. Finally, while some people believe that there is one correct answer to every question, others believe that simple, right or wrong answers rarely exist and that most questions are too complicated to be explained with only one right answer.

Sometimes, teachers and professors try to influence their students' epistemological beliefs. They can do this in subtle or obvious ways.

During the first survey you completed as part of this study, you identified one of your professors who told you about this study.

Do you believe that this professor has attempted to change your epistemological beliefs? What strategies did this professor use in order to influence your epistemological beliefs?

	Strongly Disagree				Strongly Agree
	1	2	3	4	5
2. It bothers me when instructors don't tell students the answers to complicated problems.					
3. Truth means different things to different people.					
4. Students who learn things quickly are the most successful.					
5. People should always obey the law.					
6. Some people will never be smart no matter how hard they work.					
7. Absolute moral truth does not exist.					
8. Parents should teach their children all there is to know about life.					
9. Really smart students					

don't have to work as hard to do well in school.					
10. If a person tries too hard to understand a problem, they will most likely end up being confused.					
11. Too many theories just complicate things.					
12. The best ideas are often the most simple.					
13. People can't do too much about how smart they are.					
14. Instructors should focus on facts instead of theories.					
15. I like teachers who present several competing theories and let their students decide which is best.					
16. How well you do in school depends on how smart you are.					
17. If you don't learn something quickly, you won't ever learn it.					
18. Some people just have a knack for learning and others don't.					
19. Things are simpler than most professors would have you believe.					
20. If two people are arguing about something, at least one of them must be wrong.					
21. Children should be allowed to question their parents' authority.					
22. If you haven't understood a chapter the first time through, going back over it won't help.					
23. Science is easy to understand because it contains so many facts.					
24. The moral rules I live by apply to everyone.					
25. The more you know about a topic, the more there is to					

know.					
26. What is true today will be true tomorrow.					
27. Smart people are born that way.					
28. When someone in authority tells me what to do, I usually do it.					
29. People who question authority are troublemakers.					
30. Working on a problem with no quick solution is a waste of time.					
31. You can study something for years and still not really understand it.					
32. Sometimes there are no right answers to life's big problems.					
33. Some people are born with special gifts and talents.					

Appendix D

INSTRUCTIONAL STRATEGIES AND EPISTEMOLOGICAL BELIEFS SURVEY (ISEBS)

Intro:

Epistemology is the branch of philosophy dealing with the nature and justification of human knowledge. Personal epistemological beliefs can then be understood as those beliefs an individual holds about knowledge and knowing. Most contemporary epistemological beliefs researchers believe that one's epistemological beliefs consist of independent beliefs about the certainly of knowledge, the simplicity of knowledge, the source of knowledge, the speed of learning, and the nature of intelligence. One's beliefs in one of these dimensions may not match their beliefs in another dimension, but beliefs in all dimensions can be dualistic (i.e., Knowledge is right or wrong.), relativistic (i.e., Knowledge is too complex to be characterized as right or wrong.), or committed relativistic (i.e., Knowledge is based on one's active construction of meaning, so judgment of and commitment to specific points of view is possible.).

1. Are "good" students more likely to possess dualistic, relativistic, or committed relativistic epistemological beliefs?
   a. Dualistic.
   b. Relativistic.
   c. Committed Relativistic.
2. Are "good" PK-12 teachers more likely to possess dualistic, relativistic, or committed relativistic epistemological beliefs?
   a. Dualistic.
   b. Relativistic.
   c. Committed Relativistic.
3. Are "good" teacher educators more likely to possess dualistic, relativistic, or committed relativistic epistemological beliefs?
   a. Dualistic.
   b. Relativistic.
   c. Committed Relativistic.
4. Are "good" college-level instructors (in fields other than teacher education) more likely to possess dualistic, relativistic, or committed relativistic epistemological beliefs?
   a. Dualistic.
   b. Relativistic.
   c. Committed Relativistic.

5. Do you believe that you (the instructor) can influence your students' epistemological beliefs, or do you believe that your students' epistemological beliefs change over time, independent of your instruction?

a. I can influence my students' epistemological beliefs.

b. My students' epistemological beliefs change over time, independent of my instruction.

6. Please explain the answer you provided above. Why do you feel the way that you do?

7. Do you try to design instruction that influences students' epistemological beliefs?

a. Yes.

b. No.

8. If you answered "Yes" in Item 7 above, do you focus your instruction on epistemological beliefs explicitly or implicitly? **(If you answered "No" in Item 8 above, skip to Item 10.)**

a. Explicitly.

b. Implicitly.

9. If you answered "Yes" in Item 8 above, how does your instruction reflect your efforts to influence students' epistemological beliefs? In other words, how are specific elements of your instruction designed to interact with your students' epistemological beliefs? **(If you answered "No" in Item 8 above, skip to Item 10.)**

	Strongly Disagree				Strongly Agree
	1	2	3	4	5
10. It bothers me when instructors don't tell students the answers to complicated problems.					
11. Truth means different things to different people.					
12. Students who learn things quickly are the most successful.					
13. People should always obey the law.					
14. Some people will never be smart no matter how hard they work.					
15. Absolute moral truth does not exist.					
16. Parents should teach their children all there is to know about life.					
17. Really smart students					

don't have to work as hard to do well in school.					
18. If a person tries too hard to understand a problem, they will most likely end up being confused.					
19. Too many theories just complicate things.					
20. The best ideas are often the most simple.					
21. People can't do too much about how smart they are.					
22. Instructors should focus on facts instead of theories.					
23. I like teachers who present several competing theories and let their students decide which is best.					
24. How well you do in school depends on how smart you are.					
25. If you don't learn something quickly, you won't ever learn it.					
26. Some people just have a knack for learning and others don't.					
27. Things are simpler than most professors would have you believe.					
28. If two people are arguing about something, at least one of them must be wrong.					
29. Children should be allowed to question their parents' authority.					
30. If you haven't understood a chapter the first time through, going back over it won't help.					
31. Science is easy to understand because it contains so many facts.					
32. The moral rules I live by apply to everyone.					
33. The more you know about a topic, the more there is to					

know.					
34. What is true today will be true tomorrow.					
35. Smart people are born that way.					
36. When someone in authority tells me what to do, I usually do it.					
37. People who question authority are troublemakers.					
38. Working on a problem with no quick solution is a waste of time.					
39. You can study something for years and still not really understand it.					
40. Sometimes there are no right answers to life's big problems.					
41. Some people are born with special gifts and talents.					

Appendix E

INVITATION LETTER TO POTENTIALLY PARTICIPATING INSTRUCTORS

Dear Professor,

This semester, I will conduct a study of students' personal epistemological beliefs—that is, students' beliefs about the nature of knowledge and its acquisition, correlating these beliefs with individual student characteristics (such as age, gender, ethnicity, prior academic achievement, etc.) and instructional strategies you use to teach these students. Epistemological beliefs have been linked with students' learning behaviors, and many scholars agree that sophisticated epistemological beliefs allow students to achieve improved learning outcomes. I would like to include you and your students in this study, if you are willing to participate.

Participation in this study is relatively straightforward and simple. At the beginning of the semester (during the week of 9-15 January), I will invite your students to participate in the study and ask them to complete a brief, online survey that should take them no more than 20 minutes to complete. This survey will include a brief section asking students to provide some demographic data and a slightly longer section designed to measure their epistemological beliefs. This longer, 32-item section is known as the Epistemological Beliefs Inventory (Schraw, G., Bendixen, L. D., & Dunkle, M. E., 2002). Attached to this email, you'll see a copy of this initial student survey (titled Student Characteristics and Epistemological Beliefs Survey). Next, once the semester is underway, I will ask you, the course instructor, to complete a brief survey which includes the Epistemological Beliefs Inventory mentioned above as well as a brief interview asking you to identify the major instructional strategies you utilize in your teaching. Finally, at the end of the semester, I will again ask your students to complete the Epistemological Beliefs Inventory. Rather than asking you to "require" students to participate in this study, I'd ask you to please ask students to participate. I will contact students myself in order to arrive at a respectable response rate.

Following the data collection and analysis, I will share my findings with you and your students. These findings may help you better serve your future students. Specifically, findings will provide you with a more thorough understanding of your students' epistemological beliefs, student characteristics that correlate with particular epistemological beliefs, and instructional strategies that correlate with students' epistemological development. As your students will one day be teachers themselves, this information may help them better serve their future students, as well.

I welcome any further questions you have about the study described in this email—its purpose, methods, limitations, etc. You may contact me anytime via telephone at 757-

641-4836 (cell) or 757-683-6459 (office) or via email (pbaker@odu.edu). I sincerely hope you'll choose to participate and allow your students to participate in this worthwhile study. If you would like to participate, simply reply to this email, indicating that you would like to be included in the study, and I will take care of the rest. I want to sincerely thank you, in advance, for your willingness to participate.

Your Friend and Colleague,

Peter Baker, MS Ed.

Appendix F

INVITATION LETTER TO POTENTIALLY PARTICIPATING STUDENTS

Dear Student,

I am conducting a research study right now, and I need your help! This study will explore your epistemological beliefs—that is, your beliefs about knowledge and learning. With this email, I'd like to invite/beg you to participate in this study.

Participation is really easy! All I need you to do is complete two surveys—one today and another near the end of the semester. Both surveys are brief and should take you no more than 20 to 25 minutes to complete.

One or more of your professors has agreed to participate in this study and has given me permission to contact you. In the next few days, this professor will mention my study and encourage you to participate.

In return for your participation, I'll share my findings with you and your professor in the hopes that these findings will help you know more about yourself and enable you to be a more effective teacher.

I will protect the safety and confidentiality of all information you provide for me during this study. Please also note that your participation in this study is not required, and that you can choose to stop participating at any time.

If you have any questions about this study, its methods or goals, or your rights as a participant, please contact me anytime at pbaker@odu.edu, or check out the information I've posted in the "Study Information" section of the Blackboard Organization described in the instructions below.

So, without further ado, here's how to complete the first survey!

FIRST, I've created a Blackboard Organization called "Beliefs of Teacher Education Students," and you're now a member! Follow these steps to enter this Organization.

1. Log into Blackboard.
2. Click the "My Professional Learning" tab near the top of the page (right next to the "My Blackboard & Courses" tab).
3. Click the "Beliefs of Teacher Education Students" link that will appear in the "My Organizations" box near the top of the page.

SECOND, now that you're in the "Beliefs of Teacher Education Students" Organization, you can complete my survey! Follow these steps to complete the survey.

1. Click the "Surveys" link on the left side of the page.
2. Click the "Student Characteristics and Epistemological Beliefs Survey" link.

3. Click "OK" to begin the survey.
4. Follow the instructions, and complete each item.
5. Click "Submit" to send your completed survey to me.

I truly hope that you'll choose to participate in this important study. Please remember, if you have any questions or concerns pertaining to any component of the study, you can contact me (pbaker@odu.edu) anytime. Thanks in advance for your help, and have a great day!

Sincerely,

Pete Baker, MS Ed.
Adjunct Faculty/Doctoral Candidate
Darden College of Education
Old Dominion University

Appendix G

SECOND INVITATION LETTER TO POTENTIALLY PARTICIPATING STUDENTS

Dear Student,

First, I want to sincerely thank each of you who took the time to complete my first survey earlier in the semester! I was encouraged by the large number of you who chose to participate. As I've mentioned to you before, this study would be completely impossible without your help, so I truly thank you all for your participation.

I am currently in the midst of analyzing your responses to my first survey, and I'm excited to collect the next round of survey data from you starting today! This second round of survey responses is the most important part of the study, so I want to urge you to participate.

The second survey associated with my epistemological beliefs study (Student Characteristics and Epistemological Beliefs Survey – Part Two) is currently available in Blackboard and, like the first survey, this one is brief and will take you no more than 25 minutes to complete.

In order for my study to achieve its ultimate goals, each student who completed the first survey needs to complete the second survey, as well. Those of you who did not complete the first survey are still invited to complete the second, as your responses will help me answer other questions associated with my study.

In return for your participation, I'll share my findings with you and your professor in the hopes that these findings will help you know more about yourself and enable us all to be more effective teachers.

As always, I will protect the safety and confidentiality of all information you provide for me during this study. Please also note that your participation in this study is not required, and that you can choose to stop participating at any time.

If you have any questions about the study, its methods or goals, or your rights as a participant, please contact me anytime at pbaker@odu.edu, or check out the information I've posted in the "Study Information" section of the Blackboard Organization described in the instructions below.

So, without further ado, here's how to complete the second survey! (You'll note that these instructions are nearly exactly the same as those you followed to complete the first survey.)

FIRST, follow these steps to enter the "Beliefs of Teacher Education Students" Organization I've created in Blackboard.

1. Log into Blackboard.

2. Click the "My Professional Learning" tab near the top of the page (right next to the "My Blackboard & Courses" tab).
3. Click the "Beliefs of Teacher Education Students" link that will appear in the "My Organizations" box near the top of the page.

SECOND, now that you're in the "Beliefs of Teacher Education Students" Organization, you can complete the second survey! Follow these steps to complete the survey.

1. Click the "Surveys" link on the left side of the page.
2. Click the "Student Characteristics and Epistemological Beliefs Survey – Part Two" link.
3. Click "OK" to begin the survey.
4. Follow the instructions, and complete each item.
5. Click "Submit" to send your completed survey to me.

I truly hope that you'll choose to continue your participation in this important study. Please remember, if you have any questions or concerns pertaining to any component of the study, you can contact me (pbaker@odu.edu) anytime. Thanks in advance for your help, and have a great day!

Sincerely,

Pete Baker, MS Ed.
Adjunct Faculty/Doctoral Candidate
Darden College of Education
Old Dominion University

Appendix H

SECOND INVITATION LETTER TO POTENTIALLY PARTICIPATING

INSTRUCTORS

Hi Friends and Colleagues,

I have finally put the finishing touches on the faculty survey instrument for my epistemological beliefs study! I know time is tight during this part of the semester, but I'd like to ask/beg each of you to take 25-30 minutes and complete this important survey.

Below, I will include instructions for accessing and completing the survey, but first I wanted to remind you all of a couple important details.

First, please continue to urge your students to participate in my study by completing the second student survey that's currently available.

Second, please let me know if you'd like me to provide you with lists of your students who chose to participate in my study. I'll be happy to provide these for you.

Now, without further ado, here's how to complete the faculty survey.

1. Log into Blackboard.

2. Click the "My Professional Learning" tab located at the top of the page (right next to "My Blackboard and Courses").

3. Next, on the right-hand side of the page, in the "Organizations" section, click the link to "Beliefs of Teacher Education Students."

4. In the course menu, on the left-hand side of the page, click the link to "Surveys."

5. Next, click the link to "Instructional Strategies and Epistemological Beliefs Survey -- FACULTY ONLY."

6. Click the "OK" button to begin the survey.

7. Read the Instructions at the top of the page, including the introductory paragraph on epistemology and personal epistemological beliefs.

8. Respond to each item.

9. Press the "Submit" button to send your completed survey to me.

Thanks to each of you for your willingness to participate and allow your students to participate in my study. I am excited to conclude the data collection phase and start the data analysis process, because I truly believe this study will provide us with valuable insights on student beliefs and ways in which we impact these beliefs. I can't wait to share these findings with each of you.

As always, please let me know if you have any questions or concerns pertaining to any element of my study, and I'll be happy to provide you with whatever you need.

Thanks again, and have a great day!

Pete Baker

VITA

Peter B. Baker

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Address: 989 Green Street
Portsmouth, VA 23704

Education:

Ph.D. – Curriculum and Instruction
- Old Dominion University
  - Education Building, St. 218
    Norfolk, VA 23529
- May, 2012

M.S. – General Secondary Education
- Old Dominion University
- May, 2007

B.A. – English Literature and Composition
- College of William & Mary
- May, 2005

Teaching Experience:

ECI/TLED 301 – Social and Cultural Foundations of American Education
- Professor – Summer 2008, Fall 2010, Summer 2011, Spring 2012; Guest Lecturer – Summer 2006-Spring 2008, Fall 2008-Fall 2009

ECI 635 – Research Methods in Education
- Professor – Fall 2009, Summer 2010

TLED 360 – Classroom Management and Discipline
- Professor – Fall 2010, Spring 2011, Summer 2011, Fall 2011, Spring 2012

ECI 619 – Classroom Research and Assessment
- Professor – Spring 2010; Fall 2010

TLED 430 – PK-12 Instructional Technology
- Professor – Spring 2011

TLED/READ 637 – Problems in Reading Education
- Professor – Spring 2011, Summer 2011, Fall 2011, Spring 2012

TLED 636 – Problems in Educational Research
- Professor – Fall 2011

TLED 608 – Foundations and Assessment of Education
- Professor – Fall 2011