DIFFERENCES IN PRE-SERVICE TEACHERS' EPISTEMOLOGICAL BELIEFS: A CROSS-SECTIONAL STUDY

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

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and hereby certify that, in their opinion, it is worthy of acceptance.

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……..Many people have supported me throughout my educational career, and it was this love and support which made it possible for me to be successful. First, I would like to thank my parents, Ed and Janis Hartin, for their love and encouragement, and for challenging me to always do my best. I am also grateful to my family and friends for the laughter and fun times that provided a little extra boost when I needed it the most. Finally, I would like to extend a special thanks to Cynthia who has endured the stress and chaos of the last year without complaint.

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DIFFERENCES IN PRE-SERVICE TEACHERS' EPISTEMOLOGICAL BELIEFS: A CROSS-SECTIONAL STUDY

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ABSTRACT

This study investigated the differences in epistemological beliefs of pre-service teachers in relation to their level of education and their certification area. While there has been little research done on pre-service teachers' and epistemology, it is important to understand the beliefs pre-service teachers hold regarding the nature of knowledge construction as their beliefs will influence their teaching practices. For this study, pre-service teachers were asked to complete the Epistemological Beliefs Survey (EBS) which examined their epistemic beliefs on five sub-scales: Speed of Knowledge Acquisition, Structure of Knowledge, Knowledge Construction and Modification, Characteristics of Successful Students, and Attainability of Objective Truth. Two series of ANOVAs were conducted to examine differences in pre-service teachers' levels of epistemic sophistication on these scales. While differences were found for education level (with more advanced students generally holding more sophisticated beliefs), there were no differences found in relation to certification area. This was one of the first studies in the United States to specifically investigate pre-service teachers as a unique population.

CHAPTER 1

INTRODUCTION

According to the United States Department of Labor, Bureau of Labor, there were approximately 3.5 million teachers in US public schools in 2008. The US Department of Labor (2009) goes on to note that this number is projected to increase 13% by the year 2018, for a total of approximately 4 million K-12 public school teachers. These teachers serve more than 50 million K-12 students in public schools each year (US Department of Education, 2010). Thus, public school teachers have the potential to affect a vast number of individuals annually. The ways in which teachers impact their students includes how they manage their classrooms, their pedagogical decisions, and the judgments they make. Each of these factors is influenced by a personal belief system that is carried by the teacher (Pajares, 1992; Mansour, 2008; Ogan-Bekiroglu & Akkoc, 2008; Cross, 2009). Perhaps one of the most critical belief systems to investigate with regard to education is the belief systems which incorporate knowledge and knowledge construction, or an individual's personal epistemology. Examining pre-service teachers' epistemological beliefs is one way to provide insight into how the next generation of teachers will behave in the classroom. This type of insight has implications for teacher preparation programs, including policy and curriculum decisions.

The concept of epistemological beliefs can be viewed through the lens' of several different constructs. Traditionally, and philosophically, the idea of epistemology was concerned with the origin of human understanding. (Hofer,

2002). Giving a more modern view, Hofer (2002) points out that the actual term "epistemic" goes a step further and really focuses on the acquisition of knowledge. In the fields of psychology and education, recent studies have largely concentrated on personal epistemology and epistemic cognition in order to better understand the ways in which individuals construct knowledge and understanding (Hofer, 2002).

The foundation for research on epistemology was constructed by William G. Perry, Jr. in the 1970's. He set out to study student moral development and came to the conclusion that freshman had a different view of knowledge than more experienced students. Since that time, researchers have examined the influence of individuals' beliefs about knowledge, referred to as epistemological beliefs, on such things as motivation, achievement, and even specific learning tasks like problem solving (Kardash & Scholes, 1996; Phan, 2008; Wheeler & Montgomery, 2009; Bromme, Pieschl, & Stahl, 2010).

Beginning research largely regarded individuals' beliefs about the nature of truth and knowledge as a unidimensional construct until 1990 when Schommer introduced a multidimensional approach to epistemology (Schommer, 1990; Sulimma, 2009; Wheeler & Montgomery, 2009). By looking at personal epistemology as a system of relatively independent beliefs, Schommer's work resulted in the identification of separate dimensions of epistemology (Hofer, 2002). Thus, an individual may have sophisticated beliefs in one area and more naïve beliefs in another, rather than having one universal belief system.

Characteristics of Epistemological Beliefs

Schommer (1990) described the multidimensionality of epistemic beliefs as having four distinct dimensions: 1) certainty of knowledge, 2) structure of knowledge, 3) source of knowledge, and 4) innate ability. Many current researchers utilize these dimensions as factors when studying epistemological beliefs (Schommer, 1993; Hofer & Pintrich, 1997; Hofer, 2000; Wheeler & Montgomery, 2009). Moreover, it is generally agreed that epistemological beliefs change and develop over time. This developmental trend has individuals' moving from naïve beliefs toward more sophisticated ones. This process is influenced by many factors, arguably the strongest of which is level of education (Kuhn et al., 2000). Hofer (2002) reminds us that some theorists refer to the Piagetian explanation of equilibration to explain epistemological development. Through this process, an individual would use assimilation and accommodation of schemes as a method of reconciling differences between their prior knowledge and what they are actually experiencing in their environment.

Another aspect of epistemological beliefs that has been examined is the effect of gender. Numerous studies have examined the role of gender on epistemology (Chen & Pajares, 2010; Schommer, 1993; Hofer, 2000). While some studies have found differences between genders in terms of epistemological beliefs, others have found no significant differences. Hofer (2000) examined differences in undergraduates' epistemological beliefs by discipline and gender. While differences across disciplines were found, she

concluded that there was not conclusive evidence regarding the effect of gender on epistemology (Hofer, 2000). However, a study by Wood and Kardash (2002) did find significant differences in terms of gender and education level. Their study used the Epistemological Beliefs Survey, which breaks down into five sub-scales. These sub-scales are: 1) Speed of Knowledge Acquisition, 2) Structure of Knowledge, 3) Knowledge Construction and Modification, 4) Characteristics of Successful Students, and 5) Attainability of Objective Truth. Specifically, they found that on the sub-scale of Speed of Knowledge Acquisition, females consistently had significantly higher scores than did males across all education levels. Furthermore, they found that the sub-scales of Structure of Knowledge and Knowledge Construction and Modification tended to favor males over females, but only for underclassmen (Wood & Kardash, 2002).

Other studies have focused on the ways in which cultural influences affect personal epistemology (Chen & Pajares, 2010; Schommer-Aikins & Easter, 2008; Sulimma, 2009). While within group variability must be taken into account when examining specific groups, some differences in epistemic beliefs across cultures have been noted. These differences may stem from the specific ways in which cultures view concepts such as individualism, masculinity and femininity, and social justice to name a few (Sulimma, 2009).

Another factor which may contribute to epistemological beliefs is the construct of subject domain. Buehl and Alexander (2001) suggest that individual beliefs about knowledge would vary in relationship to the degree of structure presumed to exist among domains. For example, history and reading are

assumed to be more ill structured while mathematics and physics are more structured. Similarly, Jehng et al. (as cited in Buehl & Alexander, 2001), found students majoring in “soft” fields (social sciences, arts and humanities) believed less in the certainty of knowledge and were less likely to view learning as an orderly process than students majoring in “hard” fields (business and engineering). Therefore, it could be assumed that there would be differences in pre-service teachers’ views of knowledge according to their chosen certification areas.

Pre-service Teachers’ Epistemological Beliefs

A few studies have sought to investigate the personal epistemology of individuals within the domain of teacher education. One approach examined the effect of college course work on pre-service teachers’ epistemic beliefs. A study by King et al. (2000) found that taking a course in educational psychology did affect personal epistemology even though pre-service teacher candidates did not differ significantly from college students from other majors when examining group differences in epistemological beliefs.

Another aspect of pre-service teacher epistemology that has been examined is how beliefs change over time. A study by So and Watkins (2005) found that in general, pre-service teachers tend to develop more constructivist views over time. These views are related to their conceptions and practice of teaching, as well as their ability to reflect on their teaching. Interestingly, the same study also noted that while pre-service teachers may gain personal insight

over time, their actual lesson planning process tends to become more simplistic and less integrated (So & Watkins, 2005).

Other studies have examined pre-service teachers' epistemic beliefs in terms of self-efficacy and world views. Yilmaz-Tuzun and Topcu (2008) found that pre-service teachers may have higher self-efficacy with regards to their teaching if they believe in innate ability and are relativist in their world view. On the other hand, some research has shown that pre-service teachers may believe more in learning effort than in innate ability (Cheng, Chan, Tang, & Cheng, 2009). This belief may be influenced by cultural views regarding the experience of authority.

One more aspect of pre-service teacher epistemology that has been studied is how these beliefs are related to beliefs about learning and the value of education. A study by Magno (2010) found that pre-service teachers' beliefs regarding the complexity and structure of learning, as well as the expectation for achievement may have a direct impact on the overall value placed on education.

Role of Pre-service Teacher Belief Systems

Personal epistemology focuses on beliefs regarding the nature of knowledge in general and the ways in which individuals come to know, yet epistemic beliefs alone do not make up the entirety of an individual's personal belief systems (Hofer, 2002). For example, it could be argued that teachers are influenced by many factors, both environmental and personal, that play a role in their personal belief systems. After all, individuals develop belief systems for all areas of life, including religion, politics, medicine, moral values, etc. (Pajares,

1992). However, when specifically examining personal beliefs in relationship to the field of education, one of the most important concepts to consider is knowledge construction. It is in this investigation of beliefs regarding knowledge construction that personal epistemology comes to the forefront.

The beliefs teachers hold will mold their perceptions, alter their judgment, and ultimately influence their behavior in the classroom (Pajares, 1992). Often, beliefs can turn into a form of personal knowledge. For example, a teacher may "know" that a child will never be successful in his/her classroom because the child does not assimilate new information quickly. This "knowledge" is formed from a personal belief in an epistemological construct such as quick learning or innate ability.

It has been noted that personal beliefs may override knowledge (Cross, 2009). Even though pre-service teachers may be exposed to the same course work and knowledge base, their teaching practices may differ drastically based on their own beliefs (Mansour, 2008). In light of increased awareness of the influence of teacher beliefs on classroom practice and pedagogical decisions, it can be argued that pre-service teacher beliefs should be the focus of teacher preparation programs (Cross, 2009). This becomes especially important as pre-service teacher beliefs may play a role in their personal learning when their beliefs work to constrain their own knowledge and consequently their pedagogical content knowledge (Ogan-Bekiroglu & Akkoc, 2008).

While many aspects of the personal epistemology of pre-service teachers have been studied, the research has largely been content specific and conducted

outside of the United States. No study has sought to examine epistemological beliefs of pre-service teachers across different certification areas (i.e. early childhood, elementary, English, math, science, social studies, etc), or across varying levels of educational experience (sophomores, seniors, etc).

The current study seeks to add important information to this body of research by investigating the epistemological beliefs of American pre-service teachers within different certification areas and at different stages of their educational progression. The study of epistemological beliefs of pre-service teachers holds important implications for education today. Specific components of epistemological beliefs such as speed of knowledge acquisition, structure of knowledge, knowledge construction and modification, characteristics of successful students (or innate ability), and the attainability of objective truth will no doubt influence the teaching practices of current pre-service teachers. Understanding pre-service teacher belief structures via self report instruments can also be an important tool in the evaluation of teacher preparation and practice. For example, if the majority of pre-service teachers believe innate ability, then it would become the duty of the teacher preparation program to emphasize the complexity of knowledge construction.

Research Questions and Hypotheses

The present study will seek to answer the following questions:

Q_1 Will pre-service teachers differ in their epistemological beliefs as a function of their current education level?

Q_2 Will pre-service teachers seeking an elementary certification vary in their epistemological beliefs as a function of their current education level?

Q_3 Will pre-service teachers differ in their epistemological beliefs as a function of their chosen certification areas?

Limitations of the Study

One limitation of the present study is that it used convenience sampling. Secondly, this sample is largely homogenous in nature (in terms of gender, race, and socio-economic status), and therefore it may not be appropriate to generalize results of the study to other populations. Additionally, the study relied on self-report instruments. When using self-report, there is always a risk that participants will not report their actual beliefs accurately or fully. Another limitation of the study is the cross-sectional design. While the groups are similar, actual changes over time may not be accurate due to some variation across groups. Furthermore, reliabilities of the scales used in this study ranged from .48 to .73 which was relatively low. However, these coefficients were similar to those found in other studies using the same instrument. These low reliabilities in the current study can be attributed, in large part, to the very homogenous sample. Low reliabilities on these types of scales also bring into question what is being measured by these instruments.

Delimitations of the Study

Once data were collected, this researcher chose to focus only on sophomore, senior, and graduate student populations. These populations were chosen based on sampling availability. The few freshman and juniors in the

participant pool were deleted. Additionally, it was decided to conduct the analyses using multiple ANOVAs rather than a MANOVA approach based on guidelines set forth by the developers of the Epistemological Beliefs Survey (EBS). While there was more than one instrument available to measure epistemology, the EBS was chosen for a variety of reasons including accessibility, length, and results of a study which compared various instruments.

CHAPTER 2

REVIEW OF THE LITERATURE

Characterization of Epistemology

Work on epistemology was initially conceptualized by William Perry when he noticed trends in student intellectual development while studying the moral and intellectual development of Harvard students in 1970 (Buehl & Alexander, 2001; Duell & Schommer-Aikins, 2001; Kienhues, Bromme, & Stahl, 2008; Sulimma, 2009; Weinstock & Zviling-Beiser, 2009; Wheeler & Montgomery, 2009). In his work, Perry postulated that students adopted various perspectives toward knowledge and learning and that these perspectives were related to levels of educational experience. Perry interviewed students and noted that freshman were likely to adopt a dualistic perspective of knowledge as right or wrong, while students with more experience were likely to have relativistic views (Hofer, 2000; Buehl & Alexander, 2001; Weinstock & Zviling-Beiser, 2009).

Throughout the 1980's, Perry's work was expanded in many studies to include female participants (Perry only studied male students), and develop classification schemes to incorporate what was considered to be a woman's "voice" based on female responses (Buehl & Alexander, 2001). Throughout the 1990's, researchers continued to refine these classification systems of beliefs about knowledge as they based their research on more and more varied populations of participants. Overall, much of the early research held to some general trends. First, the main interest was usually on the changes in individuals'

beliefs over time (generally associated with age and educational experience) (Buehl & Alexander, 2001). Furthermore, many conclusions regarding beliefs about knowledge came from interviews and open-ended questions, and at times epistemology was merely a side product of the research (Buehl & Alexander, 2001).

Beginning in the 1990's, some of the research regarding epistemological beliefs diverged from these initial trends. First, Schommer developed the Epistemological Questionnaire (EQ), which provided a self-report instrument for measuring personal epistemology (Buehl & Alexander, 2001). The development of this and other such instruments has allowed for researchers to statistically relate other constructs with epistemological beliefs, and consequently, research on epistemology has continued to take on a more academic focus regarding how beliefs are assessed and conceptualized (Buehl & Alexander, 2001).

It was not until Schommer's work in 1990 that epistemology was considered a multidimensional construct (Sulimma, 2009; Wheeler & Montgomery, 2009). When examining the multidimensionality of epistemic beliefs, four distinct dimensions emerged: 1) simple knowledge (knowledge viewed as isolated facts), 2) certain knowledge (knowledge is absolute), 3) innate ability (learning is a born ability), and 4) source of knowledge (views regarding the role of authority) (Schommer, 1993; Hofer & Pintrich, 1997; Hofer, 2000; Wheeler & Montgomery, 2009). Studies focusing specifically on mathematics learning added a fifth dimension of quick learning (learning happens fast or not at all) (Wheeler & Montgomery, 2009).

Even more recently, researchers have investigated domain or discipline specific epistemological beliefs. Specifically, distinct differences in epistemological beliefs have been noted within domains such as mathematics, in which students may view knowledge as passive and static (Hofer, 2000; Wheeler & Montgomery, 2009). Students may also view knowledge in science as more certain and unchanging than knowledge in psychology (Hofer, 2000). Studies of this nature have contradicted the idea that epistemological beliefs do not differ by discipline and that epistemic development is domain general.

Measuring Epistemological Beliefs

A study by Schommer (1993) investigated the development of the epistemological beliefs of secondary students over the course of their high school career and how these beliefs influenced their academic performance. Using the EQ to measure epistemological beliefs, Schommer (1993) found that epistemological beliefs do seem to move from naïve to more sophisticated over time; specifically, belief in simple knowledge, certain knowledge, and quick learning decreased from freshman to senior year. Results of the study showed that overall, the higher a student GPA, the less that student believed in quick learning (Schommer, 1993).

Duell and Schommer-Aikins (2001) authored a paper examining various instruments for measuring epistemological beliefs as well. It was determined that these instruments can be divided into two categories, unidimensional and multidimensional. The idea behind unidimensional constructs is that as one dimension of an individual's epistemology develops, other dimensions will

develop similarly, while a multidimensional approach suggests that as one dimension develops, others may not necessarily (Duell & Schommer-Aikins, 2001). Instruments falling under the unidimensional category include: Checklist of Educational Views, Reflective Judgment Interview, Reasoning About Current Issues Test, Epistemic Doubt Interview, Measure of Epistemological Reflection, Women's Ways of Knowing Interview, and the Attitudes Toward Thinking and Learning Survey. Multidimensional instruments include: Schommer's Beliefs About Knowledge and Learning, Jehng et al.'s Beliefs About Knowledge and Learning, Epistemic Belief Inventory, and Epistemological Understanding by Judgment Domain (Duell & Schommer-Aikins, 2001).

A study by Kardash and Sinatra (2003) looked at the relationship between epistemological beliefs and cognitive dispositions (tendencies toward learning and thinking such as a willingness to consider alternative points of view) in an attempt to determine if these two constructs are actually one. Kardash and Sinatra (2003) cite a number of studies which have shown that both cognitive dispositions and epistemological beliefs are likely to follow similar patterns. Using the Epistemological Beliefs Survey (EBS) to measure epistemology, and an inventory developed by Stanovich and colleagues to measure student dispositions, college students were asked to self-report their responses. In addition to this self-report data, student final exam scores and course grades were also collected (Kardash & Sinatra, 2003). Results of this study found a strong correlation between the epistemological belief scores and disposition scores. Furthermore, many of the scales in both constructs were strongly

associated with student GPA. After conducting a factor analysis of these scales, results showed considerable overlap between the two constructs (Kardash & Sinatra, 2003). However, despite shared characteristics, there were some unique distinctions found.

> Taken together, these measures tend to capture individuals' views of knowledge and learning, the tenacity with which they seek to maintain their views, and the degree to which they are willing to construct new knowledge. The dispositions instruments tend to measure individuals' tendencies and commitments, whereas the measure of epistemological beliefs focuses more on individuals' perspectives about learning and knowledge. (Kardash & Sinatra, 2003, p. 7)

A study by Stahl and Bromme (2007) specifically examined an instrument designed to measure meaningful aspects of epistemological beliefs, called the Connotative Aspects of Epistemological Beliefs (CAEB). The CAEB was constructed based on the EQ, EBI, and other previously existing instruments. Results of piloting this instrument found both a three-factor and two-factor solution (each factor made up of a series of terms to make the distinction between simplicity/certainty and variability) (Stahl & Bromme, 2007). The two-factor solution was considered the most stable and was replicated across all five data sets used for the study. Stahl and Bromme (2007) suggested that a combination of instruments might be necessary to get the most accurate measure of epistemological beliefs. Using such a combined approach might include instruments such as the CAEB, which could specifically target a

distinction between connotative and denotative aspects of epistemological beliefs (Stahl & Bromme, 2007).

Many researchers have found that epistemological beliefs can be difficult to measure using self-report instruments, yet these types of instruments are the most widely used for a number of reasons (e.g., time considerations and to support larger sample sizes without large research teams). A study by DeBacker, Crowson, Beesley, Thoma, and Hestevold (2008) examined the structure and internal consistency of three common self-report instruments used to measure domain-general epistemic beliefs. The three instruments critiqued in this study were the Epistemological Questionnaire (EQ; Schommer 1990), the Epistemic Beliefs Inventory (EBI; Schraw, Bendixen, & Dunkle 2002) and the Epistemological Beliefs Survey (EBS; Wood & Kardash 2002). Results of this study found that the EQ may have inconsistency of factors across samples and has a low internal consistency of scales (DeBacker et al., 2008). The EBI produced higher internally consistency than did the EQ, but previously small to modest sample sizes when using this instrument may have impacted earlier research (DeBacker et al., 2008). Finally, the EBS was discovered to be the least well known of these three instruments, yet produced the most desired psychometric properties in terms of the scale Speed of Knowledge Acquisition. However, the EBI outperformed the EBS on the scale Belief that Ability is Fixed (DeBacker et al., 2008). Overall, both the EBI and the EBS showed greater relative stability than the EQ (DeBacker et al., 2008).

Ordonez, Ponsoda, Abad, and Romero (2008) conducted a study in which the EQ and EBI were integrated into one new measure called the EQEBI. The study set forth to examine the psychometric properties of the combined instrument. The new instrument retained four of the five original dimensions proposed by Schommer (1990); quick learning, innate ability, certain knowledge, and simple knowledge, while omniscient authority was removed (Ordonez et al., 2008). It was found that the EQEBI had a higher reliability score than either the EQ or EBI, however; further studies would need to confirm these results.

There have been many attempts at creating instruments which accurately measure epistemological beliefs. While one of the main concerns with this is the issue of reliability and validity, others issues are present as well. As Hofer and Sinatra (2010) stated, another issue is the "degree to which dichotomous scales can be used to capture a non-dichotomous construct" (p. 116). Other issues related to the measure of epistemology include, but are not limited to, the degree of metacognitive skills an individual possesses (e.g. level of reflectivity), and response bias (based on self-report).

Epistemological Development

While it is generally agreed, regardless of theoretical construct, that epistemological beliefs do indeed change over time; the next item of focus is to identify what exactly is changing, and how. According to Kuhn, Cheney, and Weinstock (2000), the process of change by which an individual transforms from naïve beliefs toward more sophisticated ones is made up of the coordination of both the subjective and objective dimensions of knowledge. For individuals with

the most naïve beliefs, the objective dimension of knowledge overshadows the subjective dimension (Kuhn et al., 2000). In the process of maturing beliefs, a shift will occur in which just the opposite becomes true and the subjective dimension will take over the objective. For Kuhn et al. (2000), the most mature or sophisticated beliefs occur when the individual can coordinate both dimensions so that there is ultimately a balance between the subjective and objective.

The development of individual epistemological beliefs has been the object of much research (Kuhn et al., 2000; Kienhues et al., 2008). While studies on epistemology do not all share the same underlying theoretical framework, the research has assumed a change over time from simplistic beliefs toward more complex ones. For example:

> An individual initially believes that knowledge is certain and stable, either true or false, and can be handed down by an authority. Over time, he or she becomes convinced that knowledge is more complex and relativistic, accepts the uncertainty and changeability of truth, and shifts to the notion that knowledge is construed individually. (Kienhues et al., 2008, p. 546).

Often the more simplistic views are referred to as “naïve” while more complex views are considered to be “sophisticated”.

According to Kienhues et al. (2008), two basic models can be derived from the theoretical assumptions on the development of epistemological beliefs. The first of these models stems from a developmental view while the second is taken from an educational psychology view. The developmental view believes that stage like development will occur, through which the learner will develop more

sophisticated epistemological beliefs across all domains, as these domains are closely related to one another. On the other hand, the educational psychology view assumes epistemological beliefs are multidimensional and therefore a single individual may possess both naïve and sophisticated beliefs at once, as their beliefs may differ across the different dimensions (Kienhues et al., 2008).

The major factor influencing epistemological development has generally been regarded to be education. A study by Weinstock and Zviling-Beiser (2009) sought to examine the academic aspect of epistemic development from social experience. This study was conducted in Israel and used participants with similar educational backgrounds, but having different social experiences (some participants even had military experience). Epistemological beliefs were measured using the Discrepant Claims Epistemological Assessment task (Weinstock & Zviling-Beiser, 2009). Results of this study found there to be a distinct difference between groups in terms of epistemological development; specifically, students with more diverse social experiences (and military experience) were less likely to have absolutist thinking in terms of general knowledge (Weinstock & Zviling-Beiser, 2009). Furthermore, the students who did have different educational backgrounds (more years of education) were more likely to hold more sophisticated academic epistemological beliefs, but in their specific discipline only (Weinstock & Zviling-Beiser, 2009).

Effects of Culture and Gender

While much of the research regarding epistemology has been conducted among heterogeneous groups of participants, there has been some interest in

the roles of gender and culture on the formation of epistemological beliefs (Hofer, 2000). According to Chen and Pajares (2010), females may have more of a fixed view of ability than do males. Contradictory to this belief, Schommer (1993) conducted a study which showed that females were less likely to believe in quick learning and fixed ability. Similarly, Wood and Kardash (2002) also found significant gender differences. Their study of college students found that for underclassmen, males scored significantly higher than females on scales of Structure of Knowledge and Knowledge Construction and Modification while females scored higher on scales of Speed of Knowledge Acquisition and Characteristics of Successful Students (Wood & Kardash, 2002). This study also found differences for gender at the junior and senior levels. Specifically, for juniors, males scored higher on the scale of Knowledge Construction and Modification while females outscored males on the scale of Speed of Knowledge Acquisition; for seniors, females again scored higher on the Speed of Knowledge Acquisition scale, as well as the Characteristics of Successful Students and Knowledge Construction and Modification scales (Wood & Kardash, 2002).

Despite studies with such findings, Chen and Pajares (2010) noted that other studies have found no significant difference between the genders in terms of the development of epistemological beliefs. Pintrich, (as cited in Chen & Pajares, 2010) hypothesized that gender differences could only be noted when epistemology was viewed as a holistic model, but when viewed in terms of individual dimensions, no gender differences would be found. Hofer (2000)

argued that overall, it seems there is not conclusive evidence regarding the role of gender on epistemic beliefs.

In terms of race, ethnicity, and culture, African American students may have stronger incremental views of ability than White and Asian students (Chen & Pajares, 2010). However, one study by Schommer-Aikins and Easter (2008) examined the way in which epistemological beliefs affect study strategies in Asian American and European students. This study pointed out one problem with categorizing individuals into specified culture groups. The problem, according to Schommer-Aikins and Easter (2008) is that just among Asian Americans there was a large within group variability and so results could not be generalized to the entire Asian American culture. It could be assumed that this problem may hold true for other cultures and ethnic groups as well.

On the other hand, another study by Sulimma (2009) was designed to take a cross-cultural approach to examining epistemological beliefs. Here, it was argued that much of the research conducted on epistemology utilized a well-educated, North American population. This study by Sulimma (2009) investigated the possibility of defining the development of epistemological beliefs in terms of different countries cultures. Using Germany and Australia, Sulimma compared the two countries on the dimensions of power distance index, individualism, masculinity, uncertainty avoidance index, and long-term orientation. The indexes measured (in)equality of power and wealth, importance of individual rights, degree of gender differentiation, tolerance for uncertainty and ambiguity, and the

value of long-term commitments and respect of tradition respectively (Sulimma, 2009).

Results of this study showed differences across all dimensions between German and Australian citizens, but the most marked difference was in the area of individualism, in which Australian citizens proved to be much more individualistic than did Germans (Sulimma, 2009). Other differences found that Germany's gender roles are more distinct and Germans are more uncomfortable in unstructured situations (Sulimma, 2009). It was assumed that measures across these different dimensions would predict differences between Germans and Australians in terms of their epistemological beliefs. For example, for the first dimension,

> The lower the degree of power distance in a country, the more sophisticated its view of source of knowledge. For instance, if the society de-emphasizes the differences between citizens' power and wealth, people are more likely to believe that knowledge is derived from empirical evidence and reasoning. (Sulimma, 2009, p. 80)

However, despite this cross-cultural approach, the author still cautioned readers regarding over-generalization and noted that these results may not be true for every individual within the culture, a finding which was similar to the findings regarding Asian Americans in the previous study (Schommer-Aikins & Easter, 2008; Sulimma, 2009).

Metacognition and Self-Regulation

When looking at metacognition and epistemology, Hofer and Sinatra (2010) examined more in depth several concepts set forth from other research. The first issue related to metacognition and epistemology is that there has not historically been standard definitions for either concept. This can be problematic as it leads to inconsistencies in the literature and even raises a question whether or not researchers are examining the same constructs. Individually, the constructs of metacognition and epistemology are difficult to define; but the real complication arises when the task is to determine the degree to which epistemic beliefs are metacognitive (Hofer & Sinatra, 2010). For example:

> If beliefs were to be operating at the metacognitive level, learners would have to either be aware of their beliefs about the nature, source, structure, and justification of knowledge, and/or be using their beliefs about the nature, source, structure, and justification of knowledge to regulate their cognition. (Hofer & Sinatra, 2010, p. 115)

According to Hofer and Sinatra (2010), the second issue related to metacognition and epistemology is that of determining the exact relationship between the two constructs. They point out that in many cases, researchers have proposed that individuals may use their personal epistemology as a lens through which tasks are perceived and approached. Moreover, epistemological beliefs may influence personal learning expectations (Hofer & Sinatra, 2010).

The third area discussed by Hofer and Sinatra (2010) is that of the development of epistemic metacognition. While it is generally accepted that

epistemological beliefs are measured on a scale from naïve to more sophisticated, metacognitive skills are generally expressed via a more linear developmental model. As Hofer and Sinatra (2010) point out, this is problematic in that high-level thinkers, or experts in a domain, would likely have the least metacognitive awareness as their actions have become automatic.

A study by Muis and Franco (2010) used the Psycho-Epistemological Profile (PEP) and the Motivated Strategies for Learning Questionnaire (MSLQ) to measure university students' epistemic profiles and self-regulation strategies. The goal of this study was to examine the relationships between student epistemology, metacognition, and problem-solving. Results of this study showed that students profiled as having rational and empirical approaches to their knowledge were more likely to engage in self-regulatory techniques in their studies, had higher levels of problem-solving skills, and were more metacognitive (Muis & Franco, 2010).

Richter and Schmid (2010) conducted two studies examining the ways in which epistemological beliefs influence learning from text. Using German university students, the authors assessed epistemological beliefs using a German version of the Attitudes toward Thinking and Learning Survey (ATTLS), and also administered three other questionnaires related to demographic information and text-related concepts. Richter and Schmid (2010) noted that for this study, epistemological beliefs and attitudes were conceptualized as components of metacognitive knowledge. Results of the first study showed that belief in separate knowing had an indirect effect on the goal of developing an

individual point of view, specifically affecting strategic knowledge validation and consistency checking (Richter & Schmid, 2010). The second study found that participants scoring low in extrinsic motivation and high in the belief of uncertain knowledge were more likely to engage in consistency checking strategies; a result which was mediated by specific epistemic curiosities (Richter & Schmid, 2010).

Learning and Knowledge

A study by Kardash and Scholes (1996) examined the effects of people's beliefs about certain knowledge, strength of belief regarding controversial issues, and tendency to enjoy effort in thinking, on the interpretation of information presented regarding a controversial issue. This study used the EQ to measure epistemology along with several other scales. Results of this study found that the less people believe in certain knowledge, the less extreme their initial stance on a controversial issue, and the more they enjoyed cognitively challenging tasks, the more likely they were to accurately reflect on the information they were given to read (Kardash & Scholes, 1996). This finding supported the hypothesis that the strength of specific beliefs about controversial topics is as important as general epistemology in terms of determining how individuals will interpret inconclusive information (Kardash & Scholes, 1996).

Another study by Phan (2008) used second year university students to examine if epistemological beliefs influenced student learning approaches, reflective thinking, and academic performance. While research has shown a relationship between student epistemology and learning approaches, it has also

been hypothesized that epistemological beliefs may influence study strategy selection as well (Phan, 2008). Tests of two longitudinal models of academic performance showed that students' epistemological beliefs did in fact influence their approach to learning; however, support was not found for the counter argument that epistemological beliefs could be predicted by learning approach (Phan, 2008). Therefore, it can be assumed that students who selectively use certain learning approaches may be more aware of their own reflective thinking.

Stromso, Braten, and Samuelstuen (2008) conducted a study of university students in Norway to examine the prediction strength of different dimensions of epistemological beliefs on student understanding of text. This study used the Topic-Specific Epistemic Belief Questionnaire (TSEBQ) and several measures of textual understanding. Results of this study showed a strong relationship between student epistemology and understanding of multiple texts; specifically, that simplistic beliefs were a predictor of comprehension measures (Stromso et al., 2008). Furthermore, they concluded epistemological beliefs may be viewed as an aspect of domain expertise; this relationship possibly explaining why novices attempt to apply fewer heuristics than do experts when confronted with multiple texts (Stromso et al., 2008).

A study conducted in Turkey by Kizilgunes, Tekkaya, and Sungur (2009) used sixth grade students to examine the ways in which epistemological beliefs, achievement motivation, and learning relate to achievement. The results of a path analysis showed epistemological beliefs influenced learning approach directly, but also indirectly through achievement motivation (Kizilgunes et al.,

2009). Results showed that students who believed that knowledge was factual had lower levels of learning and performance goal orientations, and the learning goal orientation was positively associated with all dimensions of epistemological beliefs except certainty (Kizilgunes et al., 2009).

Liu (2009) wanted to observe how student epistemic beliefs changed over the course of a year. This study was conducted in Taiwan and focused on a course called “a historical approach to calculus” to specifically investigate not only change in epistemic beliefs over time, but also to examine if there were potential links between the development of epistemic beliefs and the course structure (Liu, 2009). Results of this study found that most students did experience a change in their epistemological beliefs over time, but the degree of this change varied drastically from one individual to the next. It was postulated that the mechanisms having the most influence on this change in epistemology were an individual’s refleciveness, integratedness, and metacognitive awareness (Liu, 2009).

A study by Sahin (2009) used the Colorado Learning Attitudes About Science Survey (CLASS) and the Force Concept Inventory (FCI, which measures understanding of Newtonian mechanics) to examine student beliefs and conceptual knowledge in a problem-based learning environment. This study was conducted in Turkey and participants were university students. Results of this study showed a relationship between conceptual knowledge and epistemological beliefs in which “students who start with more expert-like beliefs were more likely to obtain higher conceptual understanding scores at the end of

the semester" (Sahin, 2009, p. 273). However, the study also noted that while certain instructional techniques could improve student understanding of conceptual knowledge, these same instructional methods may have little or no impact on student attitudes or beliefs (Sahin, 2009).

A study of community college students' view of learning mathematics relative to their epistemological beliefs was conducted by Wheeler and Montgomery (2009). This study investigated the relationship between student beliefs about mathematics learning and their mathematics experience using Q methodology. Findings of this study indicated that regardless of student epistemology regarding mathematics (i.e. social-constructivist or absolutist), positive beliefs about the teacher were associated with more positive beliefs regarding mathematics, including perceived ability (Wheeler & Montgomery, 2009). Furthermore, students seemed to fall into one of three categories regarding their beliefs about learning. These categories were: active learners, skeptical learners, and confident learners. Skeptical learners had the strongest non-availing view of simple knowledge and preferred a systematic or algorithmic approach to learning (Wheeler & Montgomery, 2009).

A series of studies by Bromme, Pieschl, and Stahl (2010) used multiple instruments to measure epistemological beliefs in an attempt to discover *how* and *why* individual epistemological beliefs impact learning. Using college students, this study found that epistemological beliefs "act as a lens through which learners apprehend the task and thereby the knowledge which they are supposed to acquire while working on these tasks" (Bromme et al., 2010, p. 21).

Furthermore, while students had the ability to view the task through their epistemological lens, whether or not they chose to do so could be contributed to other factors. For example, two experiments in the series altered the reflective conditions of the task and found that epistemological beliefs were more likely to impact learning when reflection was adequately stimulated (Bromme et al., 2010). This finding may lend support to the hypothesis that learners can consciously choose to use the lens of their epistemology, and may in fact choose to act in a naïve manner in certain situations and more sophisticated in others due to outside influences, such as motivation for the task (Bromme et al., 2010).

Teaching and Epistemology

While much of the research regarding epistemology has used mixed major college or university students, a few studies have looked specifically at teachers and pre-service teacher candidates and their epistemological beliefs. King, Levesque, Weckerly, and Blythe (2000) conducted a study examining the effects of an educational psychology course on the epistemological beliefs of pre-service teachers. This study sought to answer the questions of whether education majors had more naïve epistemic beliefs than other college students, if pre-service teacher beliefs would change over the course of a semester, and if those changes would be temporary or more permanent (King et al., 2000). To measure epistemological beliefs, the Epistemological Belief Questionnaire (EBS) was used and measures were taken in September and May to determine change over time. Results of this study showed that while there did not appear to be significant differences between pre-service teachers and college students from

other majors, the experience of taking an educational psychology course did seem to have some effect on epistemological beliefs (King et al., 2000). Specifically, student responses changed in the areas of simple knowledge and quick learning; after taking the educational psychology course, students were more likely to believe in the complexity of knowledge. The subscales with the longest lasting effects were ambiguity avoidance and dependence on authority. This result suggests that taking a course in educational psychology gave students a greater ability to reason for themselves rather than turning to authority figures for quick answers (King et al., 2000).

A study by Sinatra and Kardash (2004) examined the relationship between pre-service teachers' views of teaching as persuasion and their level of openness to new ideas. This study used the Teaching as Persuasion instrument along with the EBS for measuring epistemological beliefs. Specifically, the study was looking at the individual differences between pre-service teacher candidates' reactions to teaching as persuasion (Sinatra & Kardash, 2004). Results of a factor analysis revealed that pre-service teachers who believed that knowledge is constructed over time were supportive of persuasion as a tool of restricting beliefs while pre-service teachers who viewed persuasion as manipulation were more resistant to change and had a stronger hold on their own beliefs (Sinatra & Kardash, 2004). Furthermore, results showed that pre-service teachers who were open-minded and believed in the individual construction of knowledge also believed that learning involves both thinking about new ideas as well as relating new information to personal experience (Sinatra & Kardash, 2004). Overall, the

teaching as persuasion model was most likely to be supported by pre-service teachers who were the most open to change (Sinatra & Kardash, 2004).

So and Watkins (2005) wanted to examine the changes in thinking that occur during the transition from pre-service teacher to professional in the field. To investigate this, they conducted a study in Hong Kong of beginning primary science teachers over the course of their transition. Using interviews, participant reflections, and lesson observation, it was found that that majority of participants became more constructivist over time in terms of their conceptions and practice of teaching, and gained in their ability to reflect in depth about their teaching (So & Watkins, 2005). However, results also showed that as individuals moved from pre-service teachers to beginning teachers in the field, their planning became more simplistic and they became less integrated in the aspects of teacher thinking (So & Watkins, 2005).

A study by Ogan-Bekiroglu and Sengul-Turgut (2008) investigated the role of constructivist teaching on student epistemological beliefs related to a physics course. This study used the Epistemological Beliefs in Physics Inventory (EBPI) along with semi-structured interviews of high school student participants. Prior to the constructivist instruction, all of the participants held realist or absolutist (the two least sophisticated) views in the dimensions of certainty, simplicity, source, and justification (Ogan-Bekiroglu & Sengul-Turgut, 2008). Results of the study showed that many students moved from the realist to absolutist view, and some even moved into a multiplist perspective across the various domains. However,

none of the participants moved into the evaluativist (most sophisticated) view (Ogan-Bekiroglu & Sengul-Turgut, 2008).

Yilmaz-Tuzun and Topcu (2008) conducted a study looking at the relationships among Turkish pre-service teachers' epistemological beliefs, self-efficacy, and epistemological world views. This study used the Epistemological World View scale, the STEBI-B self efficacy scale, and the Epistemological Questionnaire (EQ). It was found that the EQ did a satisfactory job of measuring epistemological beliefs in Turkish students. Results of this study showed that the less pre-service teachers believed in innate ability, the more likely they were to have high self-efficacy in their science teaching, feel confident about science teaching, and were relativist in their epistemological world view (Yilmaz-Tuzun & Topcu, 2008). Furthermore, pre-service teachers were confident about influencing student achievement only when knowledge was accepted as unchanging or certain (Yilmaz-Tuzun & Topcu, 2008). In this study, pre-service teachers had very sophisticated beliefs about innate ability, but maintained naïve beliefs about certain knowledge and simple knowledge (Yilmaz-Tuzun & Topcu, 2008).

One study by Cheng, Chan, Tang, and Cheng (2009) was a mixed method study conducted in Hong Kong of pre-service teachers. The goal of the study was to examine not only pre-service teachers' epistemology, but also how this related to their conceptions of teaching (Cheng et al., 2009). Findings of this study indicate that pre-service teachers tend to believe less in innate ability than in learning effort, believe in the experience of authority even when they feel doubt

regarding that authority, believe knowledge changes, and they all tended to favor constructivist conceptions (Cheng et al., 2009).

Magno (2010) conducted a study of Filipino pre-service teachers to investigate how epistemological beliefs related to beliefs about learning and the value of education. This study utilized the EQ to measure epistemological beliefs along with an instrument to measure Asian values, and one to measure identification with schools. Results of this study indicated that the value placed on education by pre-service teachers can be explained by scores on complexity and structure beliefs about learning, higher expectation for achievement, and emotional restraint (Magno, 2010).

Epistemological beliefs have been studied in-depth since the 1970's. Many different aspects of epistemological beliefs have been examined, such as developmental factors, effects of gender and culture, and how epistemology is related to motivation and learning. Moreover, the epistemological beliefs of different age groups, ranging from elementary students to college graduates, and other populations including a variety of domains of study (e.g., psychology, mathematics, and teacher education) have also been investigated. Additionally, studies have examined whether epistemological beliefs are domain specific or domain general and whether or not they change over time. However, no study has examined the epistemological beliefs of pre-service teachers with varying levels of expertise (e.g., sophomore, seniors, graduate students) and across different certification areas (e.g., early childhood, elementary,secondary). The current study seeks to fulfill this void.

CHAPTER 3

METHOD

The present study examined the relationships between pre-service teachers' epistemological beliefs, education level, and certification area. This chapter focuses on the methodology used in the study as well as the research design. Furthermore, a discussion of variables, participants, instrumentation, and reliability and validity will also be included.

Framework

The general framework for this study was constructed based on guidelines set forth by Wood and Kardash (2002). As the developers of the Epistemological Beliefs Survey (EBS), their suggestions, findings, and implications for future studies were considered when defining the design and parameters of the present study. Wood and Kardash (2002) caution against ignoring possible third variable explanations for proposed effects.

> Given that general personality variables such as need for cognition have been related to individuals' willingness to attend to and process information (Caccioppo, Petty, Feinstein, & Jarvis, 1996), it seems reasonable to include such variables in studies in order to determine whether it is the epistemology per se that is related to performance, or whether individuals who are disposed to think about information excel academically in addition to holding more sophisticated epistemological beliefs. Given that general academic aptitude and prior academic achievement are frequently available on

> undergraduate populations, it also seems reasonable to gather such information as well. (Wood & Kardash, 2002, p. 235)

Taking into account the possibility of such a third variable in the present study, participants were asked to provide explicit demographic information, including GPA (to measure academic achievement and group differences). This very brief demographic questionnaire will be discussed later in this chapter when examining materials used.

The current study also follows guidelines set by Wood and Kardash (2002) in terms of design. While it would initially seem that a MANOVA analysis would be the best design, examining the five EBS sub-scales as dependent variables and education level and certification area as independent variables, this approach may not yield the best results. Wood and Kardash (2002) note:

> Some caution is also obviously appropriate for the claim that general increase in epistemological beliefs given that educational level differences were not found after adjusting scores for general academic aptitude. As a result, it seems appropriate to conclude that the five scales described here are not facets of one underlying continuum of epistemic sophistication and that therefore a MANOVA approach is inappropriate. (p. 257)

Taking this into consideration, the present study was designed to utilize a series of ANOVAs to investigate the research questions rather than taking a MANOVA approach. However, in order to prevent alpha inflation at this level of analysis, a Bonferroni correction for multiple comparisons was applied (Tabachnick & Fidell, 2006).

Design

The methodology for the present study was made up of two distinct cross-sectional survey designs, and all data analysis was performed using PASW 18 software (formerly SPSS). The first design was a series of five two-factor Analyses of Variance (ANOVAs) in which education level (beginning sophomores, end of year sophomores, and beginning seniors) and certification area (early childhood, elementary, K12, English, math, science, and social studies) were the independent variables and one of the five sub-scale scores from the Epistemological Beliefs Survey (EBS) served as the dependent variable. The five sub-scales were: 1) Speed of Knowledge Acquisition, 2) Structure of Knowledge, 3) Knowledge Construction and Modification, 4) Characteristics of Successful Students, and 5) Attainability of Objective Truth.

Stemming from this first research design was a sub-design. For the first set of analyses, middle school and secondary certification areas were separated by content areas. These areas were: English, math, science, and social studies. However, this process yielded a small n for each content area cell compared to early childhood, elementary and K12 certification areas. To account for this, it was decided that the series of ANOVAs would be run again after collapsing all separate middle school and secondary content areas into one certification area called “secondary”. Therefore, for this design, a series of five two-factor ANOVAs were conducted using the same design as above, but the variable of certification area only consisted of early childhood, elementary, K12, and secondary.

The second main design was again a series of five one-way ANOVAs in which education level (beginning sophomores, beginning seniors, and beginning Master's students) was examined for the elementary certification area only. Here the independent variable was education level, and the dependent variables were each of the five sub-scale scores on the EBS; for a total of five separate ANOVAs. This design was constructed due to the fact that within the current sample, the elementary certification area represented a unique population. In the present teacher preparation program, all certification areas are required to successfully complete an internship (or student teaching) period. Generally, this internship lasts the duration of one semester. However, elementary education pre-service teachers are required to complete a yearlong internship (known as the Senior Year Onsite Program or SYOPS) and therefore do not attend regular classes on campus during their senior year. This difference in structure between the elementary and all other certification areas makes the elementary education pre-service teachers a unique population.

Participants

The target population for this study was pre-service teachers currently enrolled in a teacher preparation program at a large mid-western research university. This teacher development program utilizes a series of phases through which students become immersed in the culture and discipline of teaching. Admittance to the University qualifies students for admittance into phase 1 of the program. This phase is designed to give students a foundation in education before they learn about their content specific methodology; phase 1 course work

is primarily completed by the end of the sophomore year. Admittance into phase 2 requires an application and screening process. Admittance into phase 2 is highly selective and competitive (especially for content areas with limited enrollment). Criteria for Phase 2 eligibility include pre-requisite course work, GPA, and certain test scores. Phase 2 course work usually begins the junior year and is designed to give students a solid pedagogical foundation within their respective certification areas. Phase 3 of the program is made up of the student teaching internship. For Elementary majors, this internship lasts the entire duration of the senior year. For all other certification areas, the internship makes up the final semester of the senior year.

Master's level student participants were part of the Teaching Fellowship Program. This program is a highly selective induction program offered through the College of Education for first year teachers. As part of this program, students are paired with a full-time on site mentor teacher. Students are full-time first year teachers, but also complete course work which allows them to earn a Master's degree during their first year of teaching. This program allows for an intensive hands-on learning experience.

The Teacher Development and Teaching Fellowship Programs constitute a unique population. The variety and sequence of course work and field experiences offered within these programs are different than what is offered in other teacher preparation programs. Due to the uniqueness of the sample, it may be impossible to generalize these results to pre-service teachers from other teacher preparation programs.

Student participants included beginning sophomores, end of year sophomores, beginning seniors, and students just beginning a Master's level program. All certification areas were represented during the data gathering period. Data from the end of year sophomores was collected as a pilot for the current study in the Spring semester 2010 across three sections of a sophomore level course. The data for the beginning sophomores was again collected across three sections of a sophomore level course in the Fall semester 2010. The beginning Master's level student data was collected in one course in the Summer semester 2010. Data for beginning seniors was collected across three different courses in Fall semester 2010. Tables 1 and 2 describe the specific participant populations for each of the above described research designs.

Table 1

Frequencies by Education Level, Gender, and Mean Age of Participants for the Elementary Certification Area

		% Gender		Age	GPA
Education Level	N	Males	Females	M	M
Beginning Sophomores	48	4.2	95.8	19.2	3.188
Beginning Seniors	100	7	93	21.2	3.551
Beginning Master's Students	58	1.7	98.3	21.9	3.672
Total	206	4.9	95.1	20.8	3.500

Table 2

Frequencies by Education Level and Certification Area, Gender, and Mean Age of Participants

Education Level	N	% Gender		Age	GPA
		Males	Females	M	M
Beginning Sophomores	146	18.5	81.5	19.3	3.302
Early Childhood	24	0	100		
Elementary	49	4	96		
K12	11	0	100		
Middle/Secondary	62	40.3	59.7		
English	17	17.6	82.4		
Math	17	41.2	58.8		
Science	12	33.3	66.7		
Social Studies	16	68.8	31.2		
End of Year sophomores	158	23.4	76.6	19.9	3.207
Early Childhood	14	0	100		
Elementary	59	1.7	98.3		
K12	21	14.3	85.7		
Middle/Secondary	64	51.6	48.4		
English	14	35.7	64.3		
Math	18	44.4	55.6		
Science	12	41.6	58.4		
Social Studies	20	75	25		
Beginning Seniors	206	13.6	86.4	21.4	3.560
Early Childhood	19	0	100		
Elementary	99	7.1	92.9		
K12	12	16.7	83.3		
Middle/Secondary	76	25	75		
English	26	30.8	69.2		
Math	20	5	95		
Science	10	20	80		
Social Studies	20	40	60		
Total	510				3.378

Materials

Epistemological Beliefs Survey

Epistemological beliefs were measured using the Epistemological Beliefs Survey (EBS) by Wood and Kardash (2002). Wood and Kardash combined items from Schommer's (1990) and Jehng et al.'s (1993) instruments to create an 80-item survey of epistemic beliefs. Following tests of internal consistency and factor analyses, they retained 38 items representing five independent dimensions of epistemic beliefs (see Appendix A). The five subscales of the EBS include: Speed of Knowledge Acquisition (8 items), Structure of Knowledge (11 items), Knowledge Construction and Modification (11 items), Characteristics of Successful Students (5 items), and Attainability of Objective Truth (3 items). These factors were defined by Wood and Kardash (2002) as follows:

- Speed of Knowledge Acquisition – taps into beliefs about the process of learning, with emphasis on the time it takes for learning to occur: low scores represent the view that learning is a quick, straightforward process; high scores represent the view that learning is complex and gradual (requiring time and effort)
- Structure of Knowledge – low scores represent a view that knowledge is made up of discrete, unambiguous pieces of information; high scores represent the view that knowledge is complex and there may be no "one right answer"
- Knowledge Construction and Modification – examines participants' awareness that knowledge can be acquired and modified through

strategies such as integrating information from multiple sources and questioning information: low scores reflect the belief that knowledge is certain, passively received, and accepted at face value; high scores represent the view that knowledge is always evolving and is actively constructed

- Characteristics of Successful Students – low scores represent the view that successful students are "born that way" and that learning tasks for them are accomplished with little effort; high scores reflect the view that learning ability is not innate but rather something that successful students work at by committing time and effort
- Attainability of Objective Truth – low scores represent the view that there is an objective truth that can be known if scientists try hard enough to find it; high scores represent the idea that there is not "one single right answer" as well as a skepticism regarding information that is read

The Epistemological Beliefs Survey consisted of 38 items. These items were measured on a five point Likert scale: 1= strongly disagree, 2= disagree, 3= unsure, 4= agree, 5= strongly agree. Higher scores on items represented more sophisticated beliefs.

Wood and Kardash (2002) reported the internal consistency alpha coefficients of the five subscales as .74 for Speed of Knowledge Acquisition, .72 for Structure of Knowledge, .66 for Knowledge Construction and Modification, .58

for Characteristics of Successful Students, and .54 for Attainability of Objective Truth.

There are two other popular epistemological beliefs inventory the EQ and the EBI. In DeBacker et al. (2008) analysis of the three self-report instruments, the results indicated the EBS had a somewhat better fit of the five factor CFA. In fact, DeBacker et al. (2008) stated, “the majority of items on the EBS appear to be fairly good indicators of the factors that Wood and Kardash (2002) described” (p. 295).

The internal consistency alpha coefficients of the five subscales from the current study are .66 for Speed of knowledge Acquisition, .73 for Structure of Knowledge, .55 for Knowledge Construction and Modification, .65 for Characteristics of Successful Students, and .48 for Attainability of Objective Truth. These low reliability coefficients raise the question of what is actually being measured. Traditionally, epistemology has been difficult to define and other instruments attempting to measure this construct have also reported low reliabilities (DeBacker et al., 2008).

Demographic Information

Students were also asked to provide specific demographic information (see Appendix B) regarding gender, age, GPA, education level and certification area.

Procedures

After permission was granted from course instructors, the investigator visited appropriate classes and first distributed the consent form (see Appendix

C), which was read, signed, and returned. After the consent forms had been collected, participants received a packet containing the demographic information and the 38 item Epistemological Beliefs Survey. Students were allowed as much time as needed to complete the packet. After all packets were completed, they were collected by the researcher. It took each participant approximately 15 minutes to complete the packet.

CHAPTER 4

RESULTS

Analysis of Relationships between Education Level and Certification Area

A series of five two-factor ANOVAs were conducted to examine the relationships between epistemological beliefs, education level (beginning sophomores, end of year sophomores, and beginning seniors), and certification areas (early childhood, elementary, K12, English, math, science, and social studies). Tables 3-7 show scale item properties. The assumption of normality was checked and confirmed with a Q-Q plot and a non-significant Levene's Test indicated that the assumption of homogeneity of variance was also met.

Table 3

Item Properties for the Speed of Knowledge Acquisition Scale

EBS Item #	M	SD	Min	Max
3	4.29	.56	2	5
7	4.19	.57	1	5
11	4.14	.70	1	5
16	4.09	.69	1	5
18	4.28	.59	2	5
24	4.36	.62	1	5
34	4.02	.76	1	5
38	4.22	.82	1	5

Table 4

Item Properties for the Structure of Knowledge Scale

EBS Item #	M	SD	Min	Max
4	2.28	1.01	1	5
5	3.37	1.08	1	5
12	2.34	.85	1	5
13	3.59	.93	1	5
21	1.89	.85	1	5
26	3.23	1.24	1	5
28	3.79	.85	1	5
30	2.30	.99	1	5
31	2.89	1.00	1	5
33	3.39	1.03	1	5
36	2.22	.86	1	5

Table 5

Item Properties for the Knowledge Construction and Modification Scale

EBS Item #	M	SD	Min	Max
2	3.04	.99	1	5
6	3.57	.91	1	5
8	3.87	.74	1	5
10	3.75	.76	1	5
15	4.07	.75	1	5
20	3.73	.77	1	5
22	3.41	.83	1	5
23	3.93	.73	1	5
25	4.09	.69	1	5
32	3.61	.97	1	5
37	3.23	1.03	1	5

Table 6

Item Properties for the Characteristics of Successful Students Scale

EBS Item #	M	SD	Min	Max
14	3.30	1.12	1	5
17	3.68	.69	1	5
19	3.77	.96	1	5
29	3.06	1.05	1	5
35	3.97	1.00	1	5

Table 7

Item Properties for the Attainability of Objective Truth Scale

EBS Item #	M	SD	Min	Max
1	3.29	.95	1	5
9	3.71	.96	1	5
27	3.35	.89	1	5

For the first scale, Speed of Knowledge Acquisition, results of the ANOVA (see Table 9) revealed a significant main effect for education level, F (2, 490) = 4.89, p = .008. However, there was no significant main effect for certification area, nor significant interaction found between education level and certification area. A Bonferroni post-hoc analysis indicated (see Table 8 for means) that for this scale, end of year sophomores scored significantly lower (M = 32.82, SD = 3.04) than both beginning sophomores (M = 33.84, SD = 2.65) and beginning seniors (M = 33.99, SD = 2.64).

Table 8

Means and Standard Deviations for the Speed of Knowledge Acquisition Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	34.08 (4.26)	2.59	34.07 (4.26)	2.92	33.53 (4.19)	2.14
Elementary (n=207)	33.45 (4.18)	2.07	32.92 (4.12)	2.35	34.21 (4.28)	2.79
K12 (n=44)	32.46 (4.06)	3.14	32.48 (4.06)	2.71	34.67 (4.33)	3.23
English (n=57)	35.18 (4.40)	2.92	32.07 (4.01)	4.98	33.67 (4.21)	2.15
Math (n=55)	34.77 (4.35)	2.75	33.00 (4.13)	3.55	34.90 (4.36)	2.02
Science (n=34)	33.92 (4.24)	2.91	33.67 (4.21)	2.90	31.90 (3.99)	3.14
Social Studies (n=56)	33.19 (4.15)	2.88	31.90 (3.99)	3.08	33.50 (4.19)	2.37
Total (N=510)	33.84 (4.23)	2.65	32.82 (4.10)	3.04	33.99 (4.25)	2.64

Note. Mean response scores indicated in parentheses.

Table 9

Analysis of Variance Summary for Education Level and Certification Area of Pre-service Teachers on the Speed of Knowledge Acquisition Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	73.37	2	36.68	4.89	.020	.008
Error	3675.35	490	7.5			
Within Subjects						
Certification Area (B)	67.71	6	11.29	1.51	.018	.175
AB Interaction	159.21	12	13.27	1.77	.042	.051
Corrected Total	4033.88	510				

Note. N=510

The second ANOVA (see Table 11) revealed a significant main effect for education level on the Structure of Knowledge Scale, F (2, 490) = 21.15, p < .001, but did not reveal a significant main effect for certification area or a significant interaction. Post-hoc analysis (see Table 10 for means) indicated a significant difference between all education levels with end of year sophomores having the lowest scores (M = 29.09, SD = 5.54), followed by beginning sophomores (M = 30.71, SD = 5.09) and beginning seniors (M = 33.34, SD = 4.83).

Table 10

Means and Standard Deviations for the Structure of Knowledge Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	30.75 (2.80)	6.35	29.50 (2.68)	4.57	32.74 (2.98)	5.39
Elementary (n=207)	30.39 (2.76)	4.11	28.64 (2.60)	5.41	33.16 (3.01)	5.03
K12 (n=44)	29.46 (2.68)	5.01	28.71 (2.61)	6.36	34.75 (3.16)	5.15
English (n=57)	34.24 (3.11)	6.11	30.50 (2.77)	4.99	33.48 (3.04)	4.91
Math (n=55)	29.71 (2.70)	4.36	26.22 (2.38)	4.01	33.55 (3.05)	3.87
Science (n=34)	30.17 (2.74)	5.59	31.33 (2.85)	5.53	32.90 (2.99)	4.86
Social Studies (n=56)	30.19 (2.74)	4.18	30.80 (2.80)	6.45	33.80 (3.07)	4.30
Total (N=510)	30.71 (2.79)	5.09	29.09 (2.64)	5.54	33.34 (3.03)	4.83

Note. Mean response scores indicated in parentheses.

Table 11

Analysis of Variance Summary for Education Level and Certification Area of Pre-service Teachers on the Structure of Knowledge Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	1102.05	2	551.02	21.15	.079	.000
Error	12766.48	490	26.05			
Within Subjects						
Certification Area (B)	277.52	6	46.25	1.78	.021	.102
AB Interaction	368.47	12	30.71	1.18	.028	.295
Corrected Total	15062.09	510				

Note. N=510

For the Knowledge Construction and Modification scale, the third ANOVA (see Table 13) revealed significant main effects for both education level, F (2, 490) = 5.57, p = .004, and certification area, F (6, 490) = 2.31, p = .033. There was no significant interaction found. Post-hoc testing (see Table 12 for means) indicated that beginning seniors scored significantly higher (M = 41.04, SD = 3.75) than did beginning sophomores (M = 39.50, SD = 4.30). However, for certification area, post-hoc analysis did not yield any significant results.

Table 12

Means and Standard Deviations for the Knowledge Construction and Modification Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	37.75 (3.43)	4.39	40.64 (3.69)	2.02	40.37 (3.67)	4.00
Elementary (n=207)	39.16 (3.56)	4.51	39.93 (3.63)	3.59	40.76 (3.71)	3.65
K12 (n=44)	41.46 (3.77)	5.30	39.24 (3.57)	4.53	45.00 (4.09)	3.64
English (n=57)	41.12 (3.74)	3.22	40.43 (3.68)	3.88	41.37 (3.76)	3.74
Math (n=55)	39.24 (3.57)	3.38	39.61 (3.60)	3.71	40.85 (3.67)	3.88
Science (n=34)	39.50 (3.59)	4.74	40.25 (3.66)	3.49	39.70 (3.61)	1.77
Social Studies (n=56)	39.88 (3.63)	3.79	41.15 (3.74)	3.68	41.10 (3.74)	3.67
Total (N=510)	39.50 (3.59)	4.30	40.09 (3.64)	3.64	41.04 (3.73)	3.75

Note. Mean response scores indicated in parentheses.

Table 13

Analysis of Variance Summary for Education Level and Certification Area of Pre-service Teachers on the Knowledge Construction and Modification Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	164.06	2	82.03	5.57	.022	.004
Error	7214.10	490	14.72			
Within Subjects						
Certification Area (B)	203.67	6	33.95	2.31	.027	.033
AB Interaction	279.27	12	23.27	1.58	.037	.093
Corrected Total	7885.14	510				

Note. N=510

The fourth ANOVA (see Table 14) was on the Characteristics of Successful Students scale. Results of this analysis showed a significant main effect for education level, F (2, 490) = 10.12, p < .001, a significant main effect for certification area, F (6, 490) = 2.14, p = .047, and a significant interaction (see Figure 1) between education level and certification area, F (12, 490) = 2.08, p = .017.

Table 14

Analysis of Variance Summary for Education Level and Certification Area of Pre-service Teachers on the Characteristics of Successful Students Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	198.40	2	99.20	10.18	.040	.000
Error	4775.47	490	9.75			
Within Subjects						
Certification Area (B)	125.39	6	20.90	2.14	.026	.047
AB Interaction	243.44	12	20.29	2.08	.049	.017
Corrected Total	5534.89	510				

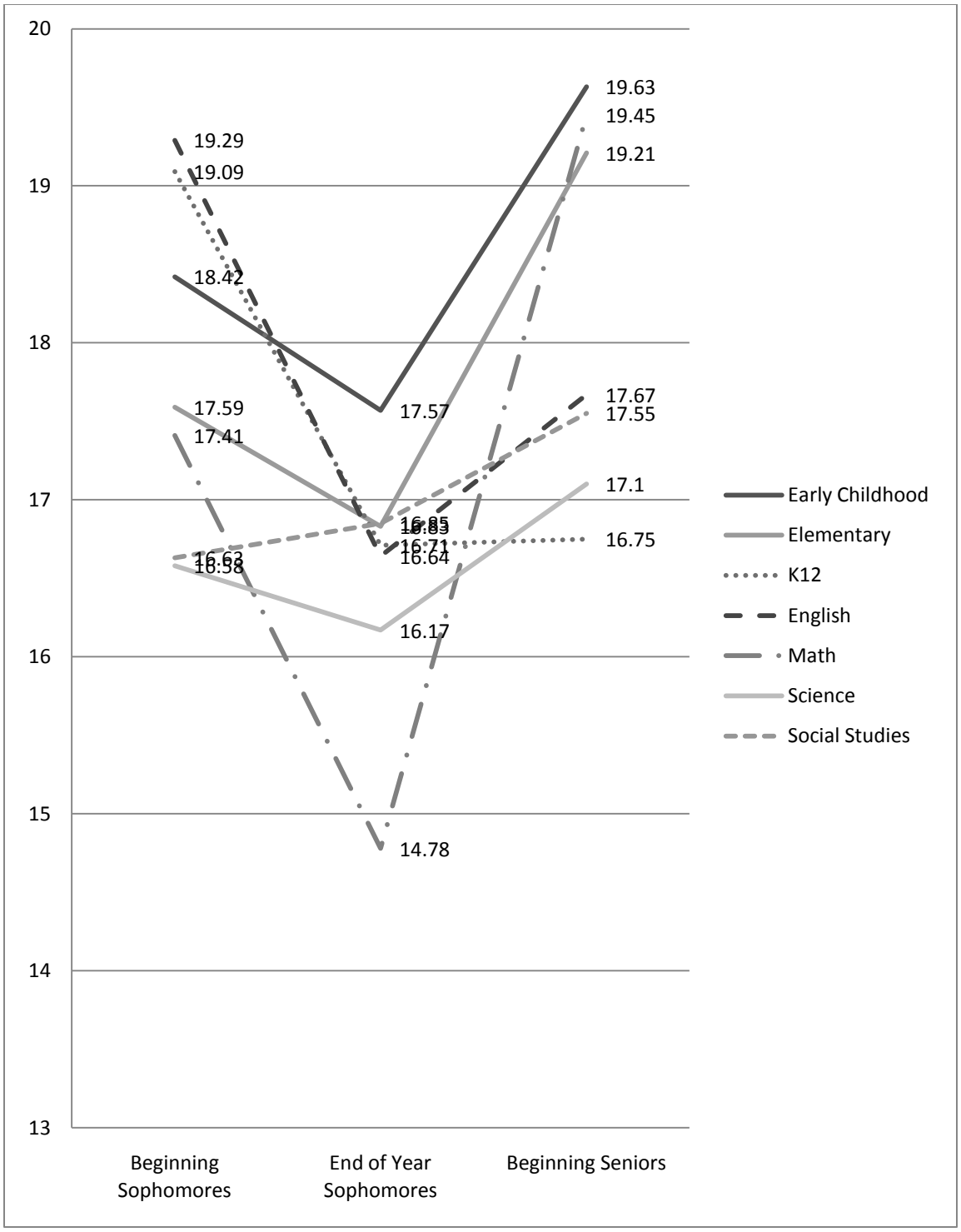

Figure 1. Mean Characteristics of Successful Students Scores as a Function of Educational Level and Certification Area.

Post-hoc analysis (see Table 15 for means) for the main effect of education level indicated significant differences between all education levels with end of year sophomores scoring the lowest (*M* = 16.58, *SD* = 3.29), followed by beginning sophomores (*M* = 17.83, *SD* = 3.14) and beginning seniors (*M* = 18.67, *SD* = 3.13). Post-hoc analysis for the main effect of certification level did not yield any significant results. Post-hoc analysis of the interaction revealed that within the beginning of year sophomore group, K12 students scored significantly higher (*M* = 19.09, *SD* = 3.56) than social studies students (*M* = 16.63, *SD* = 2.90), and English students scored significantly higher (*M* = 19.29, *SD* = 2.91) than either science students (*M* = 16.58, *SD* = 3.93) or social studies students (*M* = 16.63, *SD* = 2.90). Within the end of year sophomore group, those students seeking an early childhood certification (*M* = 17.57, *SD* = 3.72), an elementary certification (*M* = 16.83, *SD* = 3.07), or a social studies certification (*M* = 16.85, *SD* = 3.03) scored significantly higher than students seeking a mathematics certification (*M* = 14.78, *SD* = 2.78). Finally, within the beginning senior group, early childhood students (*M* = 19.63, *SD* = 2.95) and elementary students (*M* = 19.21, *SD* = 2.80) scored significantly higher than K12 students (*M* = 16.75, *SD* = 3.57), English students (*M* = 17.67, *SD* = 3.42), science students (*M* = 17.10, *SD* = 2.89), and social studies students (*M* = 17.55, *SD* = *3.90*). Additionally, mathematics students scored significantly higher (*M* = 19.45, *SD* = 2.37) than K12 students (*M* = 16.75, *SD* = 3.57).

Table 15

Means and Standard Deviations for the Characteristics of Successful Students Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	18.42 (3.69)	2.70	17.57 (3.51)	3.72	19.63 (3.93)	2.95
Elementary (n=207)	17.59 (3.52)	2.64	16.83 (3.37)	3.07	19.21 (3.84)	2.80
K12 (n=44)	19.09 (3.82)	3.56	16.71 (3.34)	3.30	16.75 (3.35)	3.57
English (n=57)	19.29 (3.86)	2.91	16.64 (3.33)	3.65	17.67 (3.53)	3.42
Math (n=55)	17.41 (3.48)	4.14	14.78 (2.96)	2.78	19.45 (3.89)	2.37
Science (n=34)	16.58 (3.32)	3.93	16.17 (3.23)	4.24	17.10 (3.42)	2.89
Social Studies (n=56)	16.63 (3.33)	2.90	16.85 (3.37)	3.03	17.55 (3.51)	3.90
Total (N=510)	17.83 (3.57)	3.14	16.58 (3.32)	3.29	18.67 (3.73)	3.13

Note. Mean response scores indicated in parentheses.

The final ANOVA (see Table 17) for the Attainability of Objective Truth scale revealed a significant main effect for education level, F (2, 490) = 4.74, p = .009. There was not a main effect for certification level or an interaction effect indicated. Post-hoc tests (see Table 16 for means) for education level showed that end of year sophomores scored significantly lower (M = 9.90, SD = 2.03) than beginning seniors (M = 10.73, SD = 1.84).

Table 16

Means and Standard Deviations for the Attainability of Objective Truth Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	9.92 (3.31)	2.10	9.14 (3.05)	1.35	10.74 (3.57)	1.76
Elementary (n=207)	10.06 (3.35)	1.66	10.09 (3.36)	1.89	11.17 (3.72)	1.65
K12 (n=44)	11.36 (3.79)	1.91	10.33 (3.44)	1.93	10.42 (3.47)	2.71
English (n=57)	10.77 (3.59)	1.95	10.00 (3.33)	2.29	10.07 (3.36)	1.47
Math (n=55)	10.06 (3.35)	2.61	10.00 (3.33)	1.68	10.15 (3.38)	2.13
Science (n=34)	10.33 (3.44)	2.10	9.75 (3.25)	2.26	10.80 (3.60)	2.70
Social Studies (n=56)	10.25 (3.42)	1.57	9.35 (3.12)	2.80	10.20 (3.40)	1.40
Total (N=510)	10.26 (3.42)	1.95	9.90 (3.30)	2.03	10.73 (3.58)	1.84

Note. Mean response scores indicated in parentheses.

Table 17

Analysis of Variance Summary for Education Level and Certification Area of Pre-service Teachers on the Attainability of Objective Truth Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	34.86	2	17.43	4.74	.019	.009
Error	1802.50	490	3.68			
Within Subjects						
Certification Area (B)	27.77	6	4.63	1.26	.015	.275
AB Interaction	52.59	12	4.38	1.19	.028	.286
Corrected Total	1954.75	510				

Note. N=510

Analysis of Relationships between Education Level and Collapsed Certification Areas

Due to a relatively small *n* for some of the middle school/secondary certification areas, these variables (English, mathematics, science, and social studies) were collapsed into one new variable called “secondary” to represent all middle school and secondary certification regardless of content area. A series of five ANOVAs were conducted on this collapsed data set. For the main effect of education level, these analyses showed the same levels of significance on all scales as the analyses without collapsed certification areas (see Tables 9, 11, 13, 14, and 17). With the collapsed certification areas, post-hoc tests were able to indicate significant differences for the main effect of certification area on two scales: Knowledge Construction and Modification, and Characteristics of Successful Students (see Tables 18 and 19). However, even with the collapsed

variables, no other scales produced significant main effects for certification area. Also, an interaction effect was only found for Knowledge Construction and Modification (see Figure 2), all other interactions were the same as with seven certification areas (see Tables 9, 11, 13, 14, and 17).

Table 18

Analysis of Variance Summary for Education Level and Collapsed Certification Areas of Pre-service Teachers on the Characteristics of Successful Students Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	154.17	2	77.08	7.76	.030	.000
Error	4956.44	499	9.93			
Within Subjects						
Certification Area (B)	89.39	3	29.80	3.00	.018	.030
AB Interaction	87.81	6	14.64	1.47	.017	.185
Corrected Total	5534.89	510				

Note. N=510

Table 19

Analysis of Variance Summary for Education Level and Collapsed Certification Areas of Pre-service Teachers on the Knowledge Construction and Modification Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level (A)	262.42	2	131.21	8.98	.035	.000
Error	7292.24	499	14.61			
Within Subjects						
Certification Area (B)	157.58	3	52.53	3.59	.021	.014
AB Interaction	244.80	6	40.80	2.79	.032	.011
Corrected Total	7885.14	510				

Note. N=510

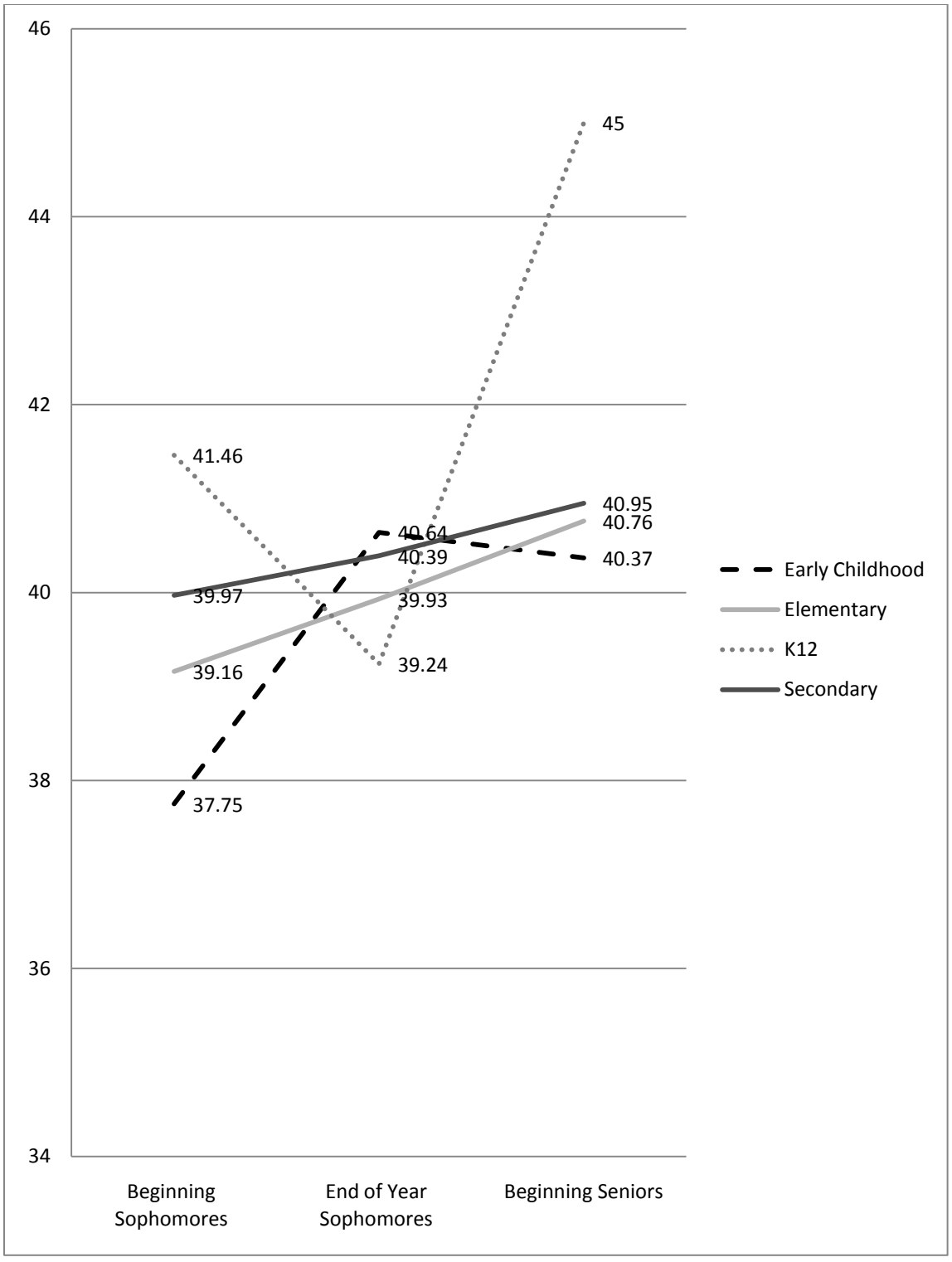

Figure 2. Mean Knowledge Construction and Modification Scores as a Function of Educational Level and Collapsed Certification Area.

For the Knowledge Construction and Modification scale, post-hoc tests revealed (see Table 20 for means) that K12 students scored significantly higher (*M* = 41.9) than early childhood students (*M* = 39.59). The Characteristics of Successful Students scale post-hoc analysis indicated (see Table 21 for means) that secondary students scored significantly lower (*M* = 17.23) than either early childhood students (*M* = 18.54) or elementary students (*M* = 17.89).

Table 20

Means and Standard Deviations for the Knowledge Construction and Modification Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	37.75 (3.43)	4.40	40.64 ((3.69)	2.02	40.37 (3.67)	4.00
Elementary (n=207)	39.16 (3.56)	4.51	39.93 (3.63)	3.59	40.76 (3.71)	3.65
K12 (n=44)	41.46 (3.77)	5.30	39.24 (3.57)	4.53	45.00 (4.09)	3.64
Secondary (n=202)	39.97 (3.63)	3.72	40.39 (3.67)	3.66	40.95 (3.72)	3.55
Total (N=510)	39.45 (3.59)	4.30	40.09 (3.64)	3.64	41.04 (3.73)	3.75

Note. Mean response scores indicated in parentheses.

Table 21

Means and Standard Deviations for the Characteristics of Successful Students Scale

	Education Level					
	Beginning Sophomores		End of Year Sophomores		Beginning Seniors	
Certification Area	M	SD	M	SD	M	SD
Early Childhood (n=57)	18.42 (3.68)	2.70	17.57 (3.51)	3.72	19.63 (3.93)	2.95
Elementary (n=207)	17.59 (3.52)	2.64	16.83 (3.37)	3.07	19.21 (3.84)	2.80
K12 (n=44)	19.09 (3.82)	3.56	16.71 (3.34)	3.30	16.75 (3.35)	3.57
Secondary (n=202)	17.57 (3.51)	3.54	16.09 (3.22)	3.39	18.03 (3.61)	3.31
Total (N=510)	17.83 (3.57)	3.14	16.58 (3.32)	3.29	18.67 (3.73)	3.13

Note. Mean response scores indicated in parentheses.

Analysis of Education Level for Elementary Certification

A series of five one-way ANOVAs were used to test for epistemological belief differences by education level (beginning sophomores, beginning seniors, and beginning Master's students) for the elementary certification area. Tables 22-26 show scale item properties. The assumption of normality was checked and confirmed with a Q-Q plot and a non-significant Levene's Test indicated that the assumption of homogeneity of variance was also met.

Table 22

Item Properties for the Speed of Knowledge Acquisition Scale

EBS Item #	M	SD	Min	Max
3	4.40	.57	2	5
7	4.21	.56	2	5
11	4.22	.68	1	5
16	4.18	.72	1	5
18	4.43	.52	3	5
24	4.41	.53	3	5
34	4.10	.71	2	5
38	4.33	.81	1	5

Table 23

Item Properties for the Structure of Knowledge Scale

EBS Item #	M	SD	Min	Max
4	2.34	.99	1	5
5	3.59	.96	1	5
12	2.52	.88	1	5
13	3.62	.82	2	5
21	2.17	.90	1	5
26	3.06	1.21	1	5
28	3.92	.70	1	5
30	2.37	1.00	1	5
31	3.09	1.01	1	5
33	3.73	.93	1	5
36	2.42	.96	1	5

Table 24

Item Properties for the Knowledge Construction and Modification Scale

EBS Item #	M	SD	Min	Max
2	3.07	.92	1	5
6	3.50	.89	1	5
8	3.89	.70	2	5
10	3.72	.82	1	5
15	4.10	.67	2	5
20	3.76	.72	1	5
22	3.36	.82	1	5
23	4.05	.73	1	5
25	4.10	.68	1	5
32	3.53	.88	1	5
37	3.21	.99	1	5

Table 25

Item Properties for the Characteristics of Successful Students Scale

EBS Item #	M	SD	Min	Max
14	3.56	1.08	1	5
17	4.06	.85	1	5
19	4.00	.86	1	5
29	3.26	1.07	1	5
35	4.15	.86	1	5

Table 26

Item Properties for the Attainability of Objective Truth Scale

EBS Item #	M	SD	Min	Max
1	3.36	.89	1	5
9	3.87	.83	2	5
27	3.55	.85	2	5

Results of the first ANOVA (see Table 28) revealed a significant main effect for education level on the Speed of Knowledge Acquisition scale, F (2, 203) = 5.09, p = .007. Bonferroni post-hoc comparisons (see Table 27 for means) of education level indicated that beginning Master's students scored significantly higher (M = 35.05, SD = 2.57) on this scale than did beginning sophomores (M = 33.46*, SD* = 2.09*).* However, no significant difference was found between sophomores and seniors or between seniors and Master's students.

Table 27

Means and Standard deviations for Education Level of Pre-service Elementary Majors

	Education Level					
	Beginning Sophomores N=48		Beginning Seniors N=100		Beginning Master's Level N=58	
EBS Sub-scale	M	SD	M	SD	M	SD
Speed of Knowledge Acquisition	33.46 (4.18)	2.09	34.20 (4.28)	2.78	35.05 (4.38)	2.57
Structure of Knowledge	30.42 (2.77)	4.15	33.12 (3.01)	5.02	34.35 (3.12)	5.06
Knowledge Construction and Modification	39.27 (3.57)	4.49	40.69 (3.70)	3.69	40.41 (3.67)	3.72
Characteristics of Successful Students	17.60 (3.52)	2.66	19.19 (3.84)	2.79	19.88 (3.98)	3.20
Attainability of Objective Truth	10.06 (3.35)	1.68	11.16 (3.72)	1.65	10.74 (3.58)	1.62

Note. Mean response scores indicated in parentheses.

Table 28

Analysis of Variance Summary for Education Level of Pre-service Elementary Majors on the Speed of Knowledge Acquisition Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level	67.55	2	33.78	5.09	.048	.007
Error	1346.76	203	6.63			
Corrected Total	1414.32	205				

Note. N=206

Results of the second ANOVA (see Table 29) revealed a significant main effect for education level on the Structure of Knowledge scale, F (2, 203) = 8.97, $p < .001$. Post-hoc tests (see Table 27 for means) revealed that beginning

sophomores scored significantly lower (*M* = 30.42, *SD* = 4.15) than did both beginning seniors (*M* = 33.12, *SD* = 5.02) and beginning Master's students (*M* = 34.35, *SD* = 5.06). Yet, there was no significant difference found between seniors and Master's students.

Table 29

Analysis of Variance Summary for Education Level of Pre-service Elementary Majors on the Structure of Knowledge Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level	421.06	2	210.53	8.97	.081	.000
Error	4763.33	203	23.47			
Corrected Total	5184.39	205				

Note. N=206

For the Knowledge Construction and Modification scale, results of the third ANOVA (see Table 30) revealed no significant main effect for education level, *F* (2, 203) = 2.19, *p* = .114. Therefore, there were no significant differences between sophomores, seniors, and Master's students on this scale.

Table 30

Analysis of Variance Summary for Education Level of Pre-service Elementary Majors on the Knowledge Construction and Modification Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level	66.73	2	33.37	2.20	.021	.114
Error	3084.94	203	15.20			
Corrected Total	3151.67	205				

Note. N=206

The fourth ANOVA (see Table 31) revealed a significant main effect for education level on the Characteristics of Successful Students scale, F (2, 203) = 8.54, $p < .001$. Post-hoc analysis indicated (see Table 27 for means) that beginning sophomores scored significantly lower (M = 17.6, SD = 2.66) on this scale than both the beginning seniors (M = 19.19, SD = 2.79) and beginning Master's students (M = 19.88, SD = 3.20). However, there was no significant difference found between seniors and Master's students.

Table 31

Analysis of Variance Summary for Education Level of Pre-service Elementary Majors on the Characteristics of Successful Students Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level	141.93	2	70.97	8.54	.078	.000
Error	1678.02	203	8.31			
Corrected Total	1828.96	205				

Note. N=206

For the Attainability of Objective Truth scale, the fifth ANOVA (see Table 32) revealed a significant main effect for education level, F (2, 203) = 7.22, $p < .001$. Post-hoc analysis (see Table 27 for means) indicated that beginning seniors scored significantly higher (M = 11.16, SD = 1.65) than did beginning sophomores (M = 10.06, SD = 1.68). Significant differences were not found between sophomores and Master's students or between seniors and Master's students.

Table 32

Analysis of Variance Summary for Education Level of Pre-service Elementary Majors on the Attainability of Objective Truth Scale

Source	SS	df	MS	F	η^2	p
Between Subjects						
Education Level	39.23	2	19.61	7.22	.066	.001
Error	551.37	203	2.72			
Corrected Total	590.60	205				

Note. N=206

CHAPTER 5

DISCUSSION

Conclusions

It has been established that epistemological beliefs tend to become more sophisticated over time (Kuhn et al., 2000; Kienhues et al., 2008). While this general trend has been studied across various populations, no study has specifically targeted pre-service teachers with regard to how their beliefs may develop over time. The present study sought to investigate if this pattern of development can be generalized to the pre-service teacher population.

When examining differences in education level (beginning sophomores, end of year sophomores, and beginning seniors) across certification levels, some surprising results surfaced (see Figure 3).

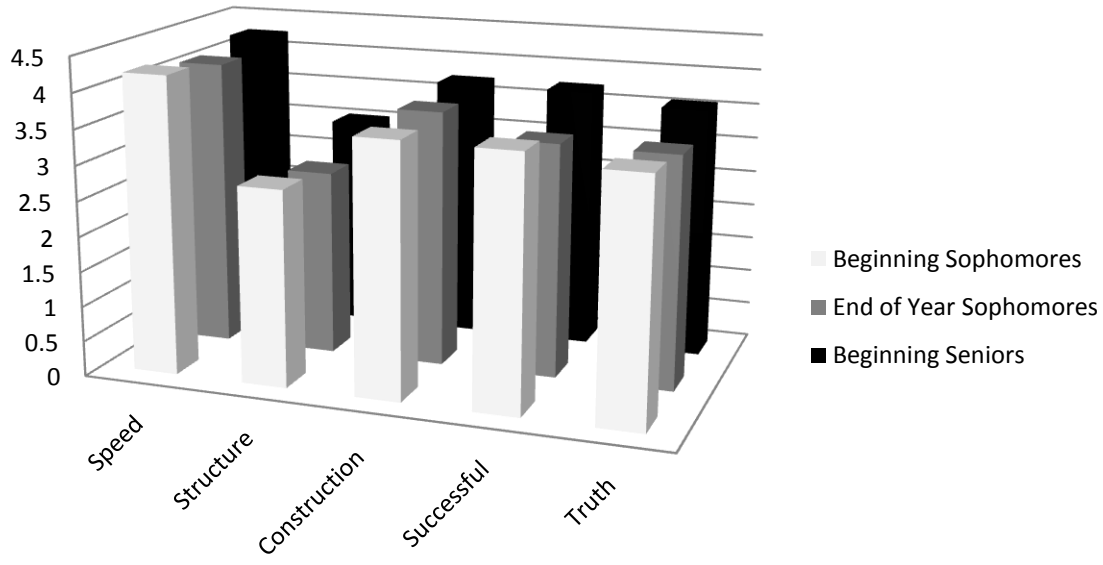

Figure 3. Main Effect Trend for Education Level across all Certification Areas.

For four scales: Speed of Knowledge Acquisition, Structure of Knowledge, Characteristics of Successful Students, and Attainability of Objective Truth, the end of year sophomores had the least sophisticated beliefs regardless of certification area. In terms of education level, this researcher expected the beginning sophomores to hold the most naïve beliefs. Moreover, for the Speed of Knowledge Acquisition and Attainability of Objective Truth scales, beginning seniors did not show more sophisticated beliefs than beginning sophomores. However, for the scales Characteristics of Successful Students and Structure of Knowledge, seniors did display more sophisticated beliefs than beginning sophomores. For the scale Knowledge Construction and Modification, beginning sophomores had the least sophisticated beliefs. One explanation for why beginning sophomores tended to have more sophisticated beliefs than end of year sophomores may be due to GPA. When looking at GPA by education level, the beginning sophomores did score higher overall than end of year sophomores. In previous research, correlations have been found between personal epistemology and academic performance (Wood & Kardash, 2002). Other studies have also found that outside influences, such as motivation, may impact epistemology (Bromme et al., 2010). Given these conflicting results, research question 1 can be answered in the affirmative; there are significant differences in pre-service teacher epistemology based on education level. Future studies may seek to explore these relationships further.

The most surprising results of the study were that certification area had virtually no impact on pre-service teachers' epistemological beliefs. Based on a

study by Buehl & Alexander (2001), which found differences in epistemology in relation to content domains, this researcher expected to find differences between certification areas. The only exceptions to this were on the Knowledge Construction and Modification and Characteristics of Successful Students scales. For both of these scales, a main effect for certification area was found. However, post-hoc analyses on both of these scales revealed no significant differences between the groups. Differences were only found on these two scales when the middle school/secondary certification areas of English, math, science, and social studies were collapsed into one variable. A possible explanation for this is that education level is a strong enough predictor of epistemic cognition and it overrides other more personal factors such as chosen certification area. Given these results, research question 3 can be answered negatively; there are no differences in pre-service teacher epistemology in relationship to their chosen certification areas.

In examining whether or not there were developmental differences due to education level of students in the elementary certification area, some significant differences were found (see Figure 4).

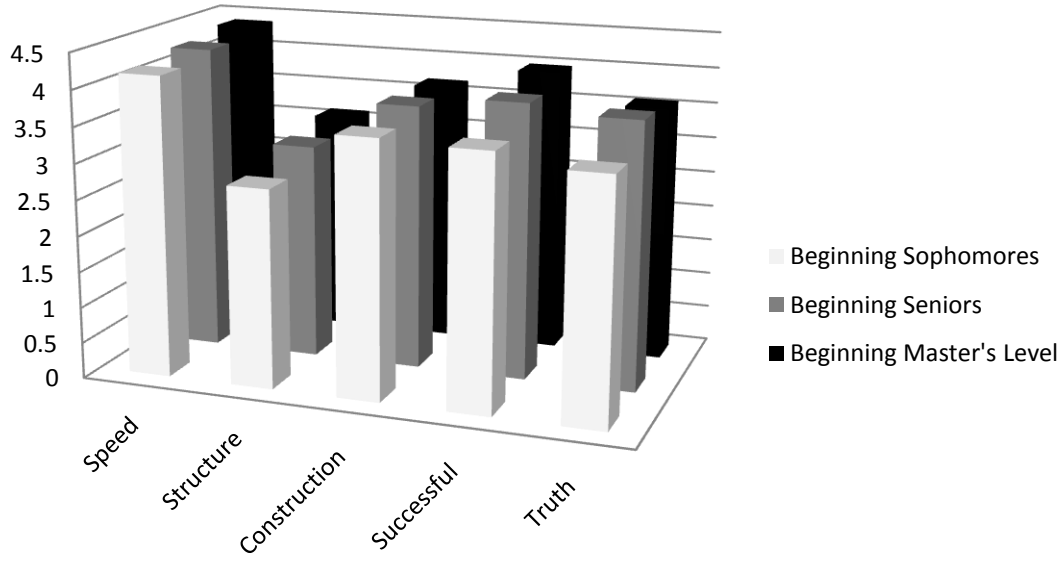

Figure 4. Main Effect Trend for Education Level for Elementary Majors.

Significant differences were found for four of the five scales of epistemological beliefs. For the Structure of Knowledge and Characteristics of Successful Students scales, both seniors and Master's students had more sophisticated beliefs than did sophomores, but there were no significant differences between seniors and Master's students. One explanation for this finding is the increased life and academic experiences of seniors and Master's students over sophomores. Older and more advanced students will have more experiences reconciling differences in information they have received. In terms of the Characteristics of Successful Students scale, seniors and Master's students have many more experiences working with students in the K-12 population and have seen firsthand the complexity of human learning and the trials students must endure to experience success. There may not be significant differences

between seniors and Master's students due to the fact that they are only separated by one year of experience, but have two or three years more experience than do students at the sophomore level.

For the scale Speed of Knowledge Acquisition, Master's students showed more sophisticated beliefs than sophomores. At the Master's level, students are less likely to believe in quick learning as they have experienced more rigorous academic demands and more courses which require independent thinking and effort.

In the examination of the Attainability of Objective Truth scale, seniors held more sophisticated beliefs than sophomores. This could be due in part to not only their increased academic experiences, but their increased social experiences as well. One study by Weinstock and Zviling-Beiser (2009) found that students who would be less likely to believe in one absolute truth were those students who had more diverse social experiences. Seniors are likely to be more involved than sophomores in both community and academic organizations.

For the Knowledge Construction and Modification scale, results surprisingly showed no differences between groups based on education level. It is possible that this could be explained by the emphasis on constructivism within the teacher preparation coursework. Students at all education levels are likely to have been exposed to the idea that knowledge is personally constructed and many pre-service teachers in this program would label themselves as a constructivist.

Given these results, research question 2 can be answered in the affirmative; pre-service teachers seeking an elementary certification do vary in their epistemological beliefs based on their current education level. Even though there were conflicting results for some of the scales, the overall trend seemed to show that within the elementary certification area, pre-service teachers' epistemological beliefs did get more sophisticated over time.

Implications for Teacher Education

Within the elementary certification group, there were no significant differences between seniors and Master's students in terms of belief sophistication. This could be due in part to the Senior Year Onsite Program (SYOP) which requires these seniors to spend their entire senior year in their student teaching placement (rather than the traditional one semester). This takes the students away from traditional course work and class settings and immerses them in the culture of their respective schools. While this is an authentic learning task, this new setting may not lend itself to students thinking academically or reflectively and therefore their epistemological beliefs do not mature. An alternate explanation for this result could be that the level of sophistication for the seniors was quite high to begin with. Perhaps the students had already reached their maximum level of sophistication by the senior year of the teacher development program.

Another result with implications for teacher education was the finding that there were no differences in epistemological beliefs across certification areas. This result conflicts with studies that have found differences across content

domains. Previous findings suggest that certain subjects, such as history and reading, are more ill structured than other subjects, such as mathematics and physics; the structure of these subjects (certification areas) should influence beliefs regarding knowledge construction (Buehl & Alexander, 2001). This result could have implications for the content area methods courses. It is possible that regardless of certification area, students are being taught methods from one perspective (likely constructivist). This unified approach may lead students to have similar beliefs regarding knowledge construction regardless of certification area.

Another result with implications for teacher education is that for all groups, the highest level of sophistication was found on the Speed of Knowledge Acquisition scale, and the least amount of sophistication was found on the Structure of Knowledge scale. The Speed of Knowledge Acquisition scale looks at beliefs about the process of learning and the time it takes for learning to occur. High scores on this scale represent the view that learning is complex and requires both time and effort. Teachers with this view might be more creative with curriculum and more interested in ideas such as differentiated instruction. Low scores on the Structure of Knowledge scale represent the view that knowledge is made up of discrete, unambiguous pieces of information, and that there is a “right answer”. Teachers with this view are likely to do a poor job of promoting transfer within their classroom and would be more likely to view their content area as a discrete entity, unrelated to other contents. This type of teaching would not help students learn the value of being able to activate prior knowledge and transfer

that knowledge to a new situation, and would ultimately hinder problem solving skill development.

Suggestions for Future Studies

Given the conflicting results obtained within this study, future research on epistemology may want to focus more on the academic aspects and influences of epistemic cognition. Further research should look specifically at the influence of specific course work on beliefs as well as prior personal experiences. Collecting demographic information regarding GPA, age, education level, etc. may not be enough. Within the pre-service teacher population, other influences (such as the amount of time spent in schools or working with children) may play a direct role in the development of epistemological beliefs.

While this study adopted a cross-sectional design, perhaps a longitudinal design would be more appropriate. A longitudinal study would better suit the examination of changes in beliefs over time. Furthermore, a longitudinal study would allow for a more in-depth look at the personal factors and experiences that may influence personal epistemology.

Future studies should also consider examining which pre-service teachers will leave the field of education to see if epistemological beliefs serve as a predictor of teacher retention. Moreover, other populations, such as those individuals with alternative certifications, should be considered for study.

The current study was able to contribute to the body of knowledge about personal epistemology by confirming the findings of other studies regarding how epistemological beliefs become more sophisticated over time and with personal

maturation and experience. Furthermore, this study presented interesting findings regarding the role of certification area on epistemology. Few studies on epistemology have specifically examined pre-service teachers, and those that have were not conducted in the United States. This study is unique in that it addresses a population which has previously been unexamined.

Appendix A

Epistemological Beliefs Survey

Please indicate how strongly you agree or disagree with each of the statements listed below. Please circle the number that best corresponds to the strength of your belief.

1. You can believe most things you read.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

2. The only thing that is certain is uncertainty itself.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

3. If something can be learned, it will be learned immediately.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

4. I like information to be presented in a straightforward fashion; I don't like having to read between the lines.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

5. It is difficult to learn from a textbook unless you start at the beginning and master one section at a time.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

6. Forming your own ideas is more important than learning what the textbooks say.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

7. Almost all the information you can understand from a textbook you will get during the first reading.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

8. A really good way to understand a textbook is to reorganize the information according to your own personal scheme.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

9. If scientists try hard enough, they can find the answer to almost every question.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

10. You should evaluate the accuracy of information in textbooks if you are familiar with the topic.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

11. You will just get confused if you try to integrate new ideas in a textbook with knowledge you already have about a topic.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

12. When I study, I look for specific facts.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

13. If professors would stick more to the facts and do less theorizing, one could get more out of college.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

14. Being a good student generally involves memorizing a lot of facts.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

15. Wisdom is not knowing the answers, but knowing how to find the answers.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

16. Working on a difficult problem for an extended period of time only pays off for really smart students.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

17. Some people are born good learners; others are just stuck with a limited ability.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

18. Usually, if you are ever going to understand something, it will make sense to you the first time.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

19. Successful students understand things quickly.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

20. Today's facts may be tomorrow's fiction.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

21. I really appreciate instructors who organize their lectures carefully and then stick to their plan.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

22. The most important part of scientific work is original thinking.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

23. Even advice from experts should be questioned.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

24. If I can't understand something quickly, it usually means I will never understand it.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

25. I try my best to combine information across chapters or even across classes.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

26. I don't like movies that don't have a clear-cut ending.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

27. Scientists can ultimately get to the truth.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

28. It's a waste of time to work on problems that have no possibility of coming out with a clear-cut answer.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

29. Understanding main ideas is easy for good students.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

30. It is annoying to listen to lecturers who cannot seem to make their mind up as to what they really believe.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

31. A good teacher's job is to keep students from wandering from the right track.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

32. A sentence has little meaning unless you know the situation in which it was spoken.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

33. The best thing about science courses is that most problems have only one right answer.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

34. Most words have one clear meaning.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

35. The really smart students don't have to work hard to do well in school.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

36. When I learn, I prefer to make things, as simple as possible.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

37. I find it refreshing to think about issues that experts can't agree on.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

38. The information we learn in school is certain and unchanging.

strongly disagree	disagree	unsure	agree	strongly agree
1	2	3	4	5

Appendix B

1. Age _____

2. Gender (circle one): Male Female

3. Current Education Level (circle one):

   Freshman

   Sophomore

   Junior

   Senior

   Graduate

4. Content Area/Grade Level (circle one):

Early Childhood Elementary K12

Middle School English	Secondary English
Middle School Math	Secondary Math
Middle School Science	Secondary Science
Middle School Social Studies	Secondary Social Studies
Middle School Other	Secondary Other

5. GPA _____

Appendix C

Please read the following information and sign your name at the bottom.

Consent to serve as a subject in research.

1. I hereby consent to take part in research conducted by Courtney Hartin under the direction of Dr. Robbie Scholes and sponsored by the Educational, School, & Counseling Psychology Department at the University of Missouri. I understand that other persons may assist Ms. Hartin in the collection of data for this experiment.

2. I understand that:

   a. This research is to investigate the change in pre-service teachers' epistemological beliefs over time.

   b. Participation in this research will take about 30 minutes.

   c. My participation is voluntary. I am free to stop participating at any time. If I do not volunteer or if my participation is ended for any reason by the researcher or me, it will have no effect on any other benefits to which I am entitled, other than those directly associated with participation in this research.

   d. I will be told of any new significant information that might affect my willingness to take part in this research.

   e. Participating in this research project poses no risks other than the stress that might be created by completing the survey.

   f. There is no other satisfactory way to get the information needed for this research.

   g. Individual questionnaires will be coded by a 3-digit number such that subjects' identities will not be attached physically to the data they contribute. Thus, there is no way to identify the data you contribute.

   h. The results of this research may be published, but I will not be identified in any such publication. I understand that all data I contribute will be kept until five years after the publication of any article to which my data might have contributed.

   i. My questions about this research have been answered. I may address further questions to Courtney Hartin/Dr. Robbie Scholes, Department of Educational Psychology, 16 Hill Hall, 884-6269.

3. I agree to allow Courtney Hartin and Dr. Robbie Scholes to perform the procedures referred to above, report their findings to government agencies, funding agencies, or scientific bodies, and to publish their findings.

Name _____ Date _____

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VITA

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