THE EFFECT OF TEACHER EARNED SUBJECT-AREA CONTENT CREDIT HOURS ON HIGH SCHOOL STUDENT ACHIEVEMENT

by

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Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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ABSTRACT

The No Child Left Behind (NLCB) Act required all elementary and secondary public school teachers to be “highly-qualified”. The NCLB’s definition of “highly qualified” required teachers hold a bachelor’s degree and demonstrate proficiency in the subjects they teach by passing a state-developed subject-matter test. Research indicated that teachers’ test scores and other measures of teacher knowledge do have a positive effect on student achievement. This correlational study determined if there was a relationship between the number of subject-area content college credit hours earned by classroom teachers and student achievement as measured by the Georgia End of Course Tests. Data were analyzed using bivariate correlational analysis and the Pearson method to determine if any statistical significant differences emerged. The results of this study indicated no significant relationship between teacher content credit hours and student achievement.

Keywords: No Child Left Behind Act (NCLB), End of Course Test (EOCT), subject-area content credit hours, student achievement, teacher quality

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English Language Learners (ELL)

End of Course Test (EOCT)

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Institutional Review Board (IRB)

National Science Teachers Association (NSTA)

No Child Left Behind (NCLB)

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Pedagogical Content Knowledge (PCK)

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CHAPTER ONE: INTRODUCTION

Background

In the past three centuries, there has been a dynamic shift in the economy and society of the United States. The American economy has gone from primarily agriculture-based in the early 19th century to technologically and digitally-driven in the 21st century. More recently, "over the past two decades, questions about teacher quality, including how teachers ought to be licensed and educated, have been ranked near the top of the educational agenda in the United States" (Cochran-Smith et al., 2012). In an attempt to address public concerns, the No Child Left Behind (NCLB) act was introduced in 2001 in order to increase school accountability, improve educational outcomes for all students, and provide better monitoring of student achievement (Boyd, Goldhaber, Lankford, & Wyckoff, 2007). The NCLB required every public school teacher be "highly qualified", which was defined as a teacher holding a bachelor's degree or higher and demonstrating subject-matter competency in core academic subjects (Marszalek, Odom, LaNassa, & Adler, 2010). NCLB also required that highly qualified teachers separately demonstrate proficiency in the subjects that they taught. For middle and high school teachers, this 'demonstration of competency' could be met by having a college major or graduate degree in the subject they taught, earning credits equivalent to a college major, passing a state-developed subject-matter test, or holding advanced certification (Dee & Cohodes, 2008). Recent research confirms that teachers are the single most important factor in determining student achievement. "Nearly all observers of the educational process, including scholars, school administrators, policy makers, and parents, point to teacher quality as the most significant institutional determinant of student achievement" (Clotfelter, Ladd, & Vigdor, 2010). Marszalek, Odom, LaNassa, and Adler (2010) state that:

> Teachers are the key to what happens in classrooms. They make the decisions about what actually gets taught and how it gets taught. They assess what students have learned and what individual needs particular students may have. Teachers are the curricular-instructional gatekeepers. (p.3)

The belief is that teachers who are "highly qualified" will have a greater impact on student achievement than teachers who are not considered "highly-qualified" because the "highly qualified" teachers have demonstrated content proficiency. Now, financially strapped school systems are seeking ways to increase student achievement on standardized tests by hiring and retaining highly qualified teachers. However, there is not much information to determine if "a teacher's quality is related to his/her credentials, or about the credential related policy levers that might be used to raise the overall quality of teachers and to ensure an equitable distribution of high-quality teachers across schools and classrooms" (Clotfelter et al., 2010, p.1).

Teacher quality has been identified as one of the most important indicators of student achievement. It is estimated that "variations in teacher quality explain between 7.5% and 8.5% of the total variation in student achievement" (Goldhaber et al., 1999, p.199). Unfortunately, there is no clear definition of what makes a good teacher. Luschei and Chudgar (2011) point out that evidence is inconclusive on the importance of teachers' educational attainment and experience.

One of the most consistent finds from the literature is that teachers' test scores and other measures of teacher knowledge do have a positive effect on student achievement (Ferguson, 1991; Goldhaber & Brewer, 2000; Monk, 1994). Additional research suggests that teachers' knowledge of the subject positively contributes to students' academic achievement (Hill et al., 2005). However, Hill (2007) has found that in the United States, teachers with higher content-specific knowledge tend to be distributed unevenly across the population, with more knowledgeable teachers working with more economically advantaged children.

In the state of Georgia, "highly qualified" teachers are required to hold a bachelor's degree, but it does not have to be in the content area they are teaching. They can simply take a test on the content to earn certification in that area and be considered "highly qualified". When data is considered on highly qualified versus non-highly qualified teachers, there is no distinction between those that took many college courses in their field and those that simply knew enough content to pass the certification test (Georgia Professional Standards Commission, 2014). The purpose of this correlational study was to determine if there was a relationship between the number of subject-area content credit hours earned by classroom teachers and student achievement as measured by the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests.

Problem Statement

Research indicates that teacher quality is one of the most important indicators of student achievement. Goldhaber et al. (1999) and Rivkin et al. (2005) estimate that "variations in teacher quality explain between 7.5% and 8.5% of the total variation in student achievement" (p.199). However, it is unclear what exactly makes a good teacher. Additional research is inconclusive on evidence of the importance of teachers' educational attainment and experience (Luschei & Chudgar 2011). This study was to determine if there was a relationship between the number of subject-area content credit hours earned by classroom teachers and student achievement as measured by the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests.

Purpose Statement

The purpose of this correlational study was to determine the effect of teacher earned subject-area content credit hours on student achievement at a rural north Georgia high school. The antecedent variable was generally defined as the number of college subject-area credit hours earned by teachers. The consequent variable was generally defined as student achievement as measured by the percentage of students scoring at the Meets or Exceeds level on the End Of Course Tests in Biology, Physical Science, American Literature, 9th grade Literature, Coordinate Algebra, Analytic Geometry, United States History, and Economics.

Research Question(s)

The research questions for this study were**:**

RQ1: Is there a relationship between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology End Of Course Test and the Physical Science End Of Course Test?

RQ2: Is there a relationship between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra End Of Course Test and the Analytic Geometry End Of Course Test?

RQ3: Is there a relationship between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History End Of Course Test and the Economics End Of Course Test?

RQ4: Is there a relationship between the number of college-level English literature content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature End Of Course Test and the American Literature End Of Course Test?

RQ5: Is there a relationship between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests?

Null Hypotheses

$H_0$1: There will be no significant correlation between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology End Of Course Test and the Physical Science End Of Course Test.

$H_0$2: There will be no significant correlation between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra End Of Course Test and the Analytic Geometry End Of Course Test.

$H_0$3: There will be no significant correlation between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History End Of Course Test and the Economics End Of Course Test.

$H_0$4: There will be no significant correlation between the number of college-level English literature content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature End Of Course Test and the American Literature End Of Course Test.

$H_0$5: There will be no significant correlation between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests.

Identification of Variables

The antecedent variable in this study was the number of subject-area content credit hours earned by teachers during their college careers. These content hours could be courses in any of the four main academic areas (mathematics, science, social studies, English literature). Additionally, these hours may have been earned during the teacher's undergraduate and/or graduate studies.

The consequent variable in this study was the percentage of students scoring at the Meets or Exceeds level on the Georgia End Of Course Tests (EOCT) for all four academic subject areas. The exams were given to students enrolled in Biology, Physical Science, American Literature, 9th Grade Literature, Coordinate Algebra, Analytic Geometry, United States History, and Economics courses at the end of the fall and spring semesters. Exams in all content areas were administered in two sixty-minute sections over two days via computer.

Definitions

1. *Pedagogical Content Knowledge* (PCK): According to Shulman (1987), PCK includes a teacher's "knowledge of how particular subject matter topics, problems, and issues can be organized, represented, and adapted to the diverse interests and abilities of learners and presented for instruction. It represents the synthesis of teachers' knowledge of both subject matter and pedagogy, distinguishing the teacher from the content specialist" (p.13).
2. *Content Knowledge* (CK): Kleickmann et al. (2013) defines content knowledge (CK) as the representation of a teacher's understanding of the subject matter being taught.
3. *End of Course Test* (EOCT): The EOCTs are standardized achievement tests designed by the Georgia Department of Education and aligned with the Georgia curriculum standards and include the assessment of the specific content knowledge and skills. The tests provide data to evaluate student strengths and areas of needed improvement (EOCT, 2013).
4. *No Child Left Behind Act* (NCLB): Signed into law by President George W. Bush in 2001, NCLB defines a highly qualified teacher as "having completed a teacher education program and earned a bachelor's degree, thereby obtaining full state certification; being placed in a position which matches his/her area of certification; and not having had certification or licensure requirements waived on an emergency, temporary, or provisional basis" (Marszak et al., 2010).
5. *Self-efficacy*: Erlich and Russ-Eft (2011) define self-efficacy as "one's confidence in engaging in specific activities that contribute toward progress to one's goal" (p.5).

6. *Social Cognitive Theory*: Developed by Albert Bandura, social cognitive theory suggests that “perceptions of the self mediate human behavior; individuals confer meaning and weight to happenings in their environment through the filter of their beliefs about themselves (Soodak, Podell, & Lehman, 1998, p.482).

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

One of the strongest predictors of student performance on a national assessment is the percentage of teachers who are "well-qualified", or those who majored in the subjects they taught and were state certified (Darling-Hammond, 2000; National Commission on Mathematics and Science Teaching for the 21st Century, 2000). The examination of what teachers need to know about the subject matter they will be teaching is an important factor in the development of teacher education programs, teacher certification programs, and professional development curriculum (Shulman, 1987). It is also crucial to designing successful pre-and in-service training programs (Zongyi, 2007). The development of content knowledge (CK) initially comes from a student's K-12 science learning experiences and continues on into the college level, particularly in undergraduate science courses (Friedrichsen et al., 2009). The development of pedagogical content knowledge (PCK) typically begins during the first years of university teacher education programs (Kleickmann et al., 2013). Ojose (2012) states that "common sense dictates that we cannot teach what we do not know: content knowledge is needed. In the same reasoning, we cannot effectively teach content we know quite well if we lack knowledge of teaching" (p. 151).

Theoretical Framework

Pedagogical content knowledge (PCK) can be defined as "the ways of representing and formulating the subject that makes it comprehensible to others" (Boz, 2012, p. 343). It is dynamic, not static, involves the transformation of other types of knowledge, and science subject matter knowledge is central to the development of PCK (Abell, 2008). Shulman (1987) first coined the term pedagogical content knowledge in reference to a specific form of knowledge unique to teachers. He defined PCK as “that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding” (Shulman, 1987, p. 342). Shulman’s work continues to prove useful to researchers by allowing them to identify distinctions in teacher knowledge that can make a difference in effective teaching (Ball, Thames, & Phelps, 2008). According to Abell (2008), not only do teachers possess PCK, “they employ the components of PCK in an integrated fashion as they plan and carry out instruction. Teacher use of PCK involves blending individual components to address the instructional problem at hand” (p. 1407). PCK can also be divided into four levels: General, subject-specific, domain-specific, and topic-specific (Nezvalová, 2011).

General PCK

Nezvalova (2011) states that a teacher possessing general PCK has sound knowledge of pedagogical concepts. It is more specific than basic pedagogy because the strategies employed are specific to a specific subject (Veal & MaKinster, 1999).

Subject-specific PCK

Subject-specific PCK refers to the specific discipline. For example, subject-specific PCK for teaching science might include such topics as: Nature of science, discovery, inquiry, project-based science, and process. These strategies can be considered subject-specific because their focus is on science (Nezvalová, 2011).

Domain-specific PCK

Domain-specific PCK is “more distinct than general PCK, because it focuses on one of the different domains or subject matters within a particular discipline” (Nezvalova, 2011, p. 107), such as biology, Earth science, chemistry, and physics (Veal & MaKinster, 1999).

Topic-specific PCK

Topic-specific PCK is related to an understanding of topics, terms, and concepts specific to each science domain (Veal & MaKinster, 1999). A teacher who has topic-specific PCK has a "repertoire of skills and abilities in the previous three levels" (Nezvalova, 2011, p. 107).

In a follow-up 2003 study, Veal and Kubasko explored the topic-specific nature of PCK by studying the practices used by both biology and geology teachers as they taught a unit on the topic of evolution. Using observations and interviews, the researchers concluded that the content background of the teachers influenced their approach to the teaching of evolution. They also determined that varying levels of complexity in topic-specific PCK was present in beginning teachers and in experienced (Veal & Kubasko, 2003). In a related study conducted by Lee (2008), it was demonstrated that general PCK consists of different areas that are each emphasized in different ways, meaning that all teachers maintain a core PCK, composed of knowledge of goals, content, and students, and these varying components exist in different orientations and positions as PCK is represented through a topic or domain. This suggested, "teachers concurrently hold different forms of PCK, but the forms evolve differently at different points in their careers. Thus, beginning teachers do not primarily hold domain and topic orientations— they can also hold general orientations that are also developing, but all have knowledge of content, goals, and students at the core" (Lee, 2008, p.1360). However, it was Freidrichsen et al. (2009) who identified three potential sources of subject-matter knowledge: (a) K-12 experiences of the teacher, (b) classroom teaching experiences, and (c) teacher education programs and professional development.

According to Alanzo, Kobarg, and Seidel (2012), most teachers are unaware of knowledge they use to make “instructional decisions, and day-to-day discussions of teaching tend to center around practices, rather than the knowledge and reasoning underlying them” (p. 1215). So, because teaching itself does not require “articulation of PCK, teachers may not possess a shared language with which to communicate this knowledge” to each other or to their students. (Baxter & Lederman, 1999, as cited in Alanzo, Kobarg, & Seidel, 2012, p. 1215). In a 2012 study, Alanzo et al. (2012) investigated mechanisms by which PCK might affect student outcomes in the classroom by contrasting two German physics teachers with high and low gains in student knowledge. The study found that teachers must also be able to “make connections between various instructional representations and the content they can help to illuminate” (Alanzo et al., 2012, p. 1231). In short, PCK is what “allows excellent teachers to make disciplinary ideas comprehensible to non-experts. It distinguishes a teacher from disciplinary experts, as well as from colleagues who teach other subject matter” (Alanzo et al., 2012, p. 1216).

Content Knowledge

According to Baumert et al. (2010), in the research literature there is an understanding that “domain-specific and general pedagogical knowledge and skills” are important indicators of “instructional quality that affect students’ learning gains and motivational development” (p.135). However, there have been few empirical studies directly assessing the various components of teachers’ knowledge and using those components to predict instructional quality and student achievement. There are contrasting opinions on exactly what is meant by subject matter knowledge. Do secondary academic teachers need an understanding of the academic research knowledge taught in universities? Or is it the subject matter knowledge for teaching that is most important, integrating both subject and instructional knowledge, as taught in schools of education? (Baumert et al., 2010). There is agreement among educators that ‘‘teachers must know in detail and from a more advanced perspective the … content they are responsible for teaching . . . both prior to and beyond the level they are assigned to teach’’ (National Mathematics Advisory Panel, 2008, p. 37). “What is required is a conceptual understanding of the material to be taught” (National Mathematics Advisory Panel, 2008, p.37).

Kleickmann et al. (2013) defines content knowledge (CK) as the representation of a teacher’s understanding of the subject matter being taught. Some of the strongest findings on the effect of CK come from studies that show increased student achievement when teachers have strong knowledge of the discipline they teach (Goldhaber & Brewer, 2000). A major finding of qualitative studies on mathematics instruction is that the “repertoire of teaching strategies and the pool of alternative mathematical representations and explanations available to teachers in the classroom are largely dependent on the breadth and depth of their conceptual understanding of the subject” (Baumert et al., 2010, p. 138). These studies also revealed that “an insufficient understanding of mathematical content limits teachers’ capacity to explain and represent that content to students in a sense-making way, a deficit that cannot be offset by pedagogical skills” (Baumert et al., 2010, p. 138). Qualitative research on teacher knowledge indicates that the subject-specific knowledge required for high-quality instruction is not general knowledge that can be picked up casually, but “profession-specific knowledge” acquired at the university-level and cultivated through reflection on classroom experience (Grossman, 2008). In a study designed to investigate mathematical CK of algebra teachers, Ojose (2012) found that teachers who “possess knowledge of the presented mathematical axioms were able to (a) describe lesson enactment using methods consistent with constructivism, (b) relate lessons to real-life situations, (c) offer rationales for steps involved in working a problem, and (d) provide alternative ways to solving problems” (p. 160). Ojose (2012) also found that teachers with thorough CK were able to more accurately “describe teaching enactments in convincing, innovative, and sometimes fun ways,” (p.161) while teachers with little or no CK “offered skeletal explanations loaded with routines and rituals consistent with traditional instructional practices” (p. 161), thus suggesting that limited CK can lead to a narrowing of the material to which students are exposed. In short, it is impossible for teachers to effectively teach concepts that they do not understand (Ojose, 2012).

However, content knowledge is not effective in the classroom unless accompanied by a varied repertoire of subject specific skills relating directly to instruction, curriculum, and student learning (Baumert et al., 2010). These findings are supported by case studies of instructional episodes, showing that teachers with equal levels of content knowledge may differ in their pedagogical skills depending on teaching experiences (Schoenfeld, 1998; Schoenfeld, Minstrell, & van Zee, 2000). Kahan, Cooper, and Bethea (2003) state that strong content knowledge is ‘‘a factor in recognizing and seizing teachable moments” (p.245), but it does not guarantee genuine learning experiences for students. According to Ball et al. (2001), it is actually pedagogical content knowledge:

> that underlies the development and selection of tasks, the choice of representations and explanations, the facilitation of productive classroom discourse, the interpretation of

> student responses, the checking of student understanding, and the swift and correct analysis of student errors and difficulties. (p. 391)

Thus, a profound understanding of the subject matter taught is crucial to quality instruction, but pedagogical knowledge is also necessary to effectively teach the content (Borko & Livingston, 1989; Kahan et al., 2003).

Subject Matter Knowledge

Subject matter knowledge (SMK) includes both science content knowledge and knowledge of science teaching, whereas PCK includes the "constituent components of knowledge for teaching science teachers in terms of particular topics and grade levels, including knowledge of science teachers as learners, and knowledge of science teacher education curriculum, instruction, and assessment" (Abell, 2008, p. 1414). Within SMK, Shulman (1987) included substantive and syntactic knowledge. Substantive knowledge is understanding the body of knowledge generated by a discipline, and syntactic knowledge, or epistemic knowledge, refers to understanding how ideas are developed and become accepted within a given discipline (Schwab, 1964, as cited in Anderson & Clark, 2012). For science teachers in particular, SMK includes "knowledge of general concepts, principles and conceptual schemes, together with the detail related to a science" (Anderson & Clark, 2012, p. 316).

In a 2006 study, Appleton (as cited in Anderson & Clark, 2012) investigated how elementary teachers possessing little SMK still managed to effectively teach science. Some teachers cover this deficit by avoiding teaching science completely, while others with little or no science background actually teach it quite well (Traianou, 2006). Schulman (1987) considered scholarship in specific content disciplines a vital component in the development of the knowledge required for teaching. Of particular interest to researchers is how science teachers build their knowledge of science, since many elementary teachers are generalists, meaning they have little or no background in science (Appleton, 2006, as cited in Anderson & Clark, 2012). Lave and Wenger (1998) view learning as "increasing participation in communities of practice. Such participation is frequently limited or non-existent for elementary teachers with respect to science. In cases, where participation is limited, documentation of practice (reifications) may serve as tools for learning" (p.789). In order to combat the lack of science SMK, countries such as the United Kingdom have begun to require that teacher education courses include more science content (Osborne & Simon, 1996). This has resulted in increasing research in the area of elementary teachers' SMK mainly through structured interviews and questionnaires (Summers, Kruger, Mant, & Childs, 1998). As pointed out by Traianou (2006), "issues of science content faced in the classroom are not well defined and SMK is better studied in practice". She goes on to suggest that teachers' SMK is "functional, context-specific, and integrated with features of the classroom situation or the task teachers are trying to accomplish" (p. 838).

Multiple studies of teachers' scores on the National Teacher Examinations (NTE) subject matter tests have failed to identify a consistent relationship between this measure of subject matter knowledge and teacher performance as measured by student outcomes. Most studies provide both positive and negative statistically insignificant relationships (Darling-Hammond, 2000). In a summary review of the results of thirty case studies relating teachers' SMK to student achievement, in which teacher knowledge was measured with either a subject knowledge test or the number of subject area college courses taken, Byrne (1983, as cited in Darling-Hammond, 2000) found mixed results with 17 studies showing a positive relationship and 14 studies showing no relationship at all. Byrne noted that many of the "no relationship" studies had such minimal variability in the teacher knowledge measure that insignificant findings were almost guaranteed. In a 1987 study review, Ashton and Crocker (1987) found a positive relationship between measures of SMK and teacher performance in only 5 out of a total of 14 studies. These mixed results occur because SMK is a positive factor only up to a level of basic competence in the subject area, but becomes less important as a teacher gains more experience (Darling-Hammond, 2000).

In a study of middle school mathematics teachers, all with equal years of experience and in similar school settings, it was found that students with fully certified mathematics teachers made significantly larger gains on achievement tests than those students whose teachers were not certified in mathematics. Additionally, algebra students showed greater gains than the general mathematics students (Hawk, Coble, & Swanson, 1985). Thus, knowledge of the material being taught is essential to good teaching, but returns to subject matter expertise will “grow smaller beyond some minimal essential level which exceeds the demands of the curriculum being taught” (Darling-Hammond, 2000, p.4). This conclusion is supported by Monk's (1994) study of mathematics and science achievement. Using data from the Longitudinal Study of American Youth, he found that teachers' coursework in the subject field increases student achievement in mathematics and science, however there are diminishing returns to student achievement of teachers' subject matter courses above a certain threshold level (e.g., five courses in mathematics). Performing a multilevel analysis of the same data, Monk and King (1994, as cited in Darling-Hammond, 2000) found statistically insignificant positive and negative effects of teachers' SMK on student achievement. However, some evidence of the cumulative effects of prior as well as proximate teachers' SMK on student performance in mathematics was obtained, with the effects differed for high- and low-achieving students and among varying grade levels. Druva and Anderson (1983) reviewed 65 studies of science teachers' characteristics and behaviors, and found that students' science achievement was positively related to the teachers' background in both education and science. This relationship was greater in higher level science courses, a result similar to that found by Hawk, Coble, and Swanson (1985) in mathematics.

A case study by Anderson and Clark (2012) analyzed a New Zealand elementary school teacher using a framework based on Shulman’s conceptualization of teacher knowledge. The study described the development of the teacher’s SMK and PCK as she planned and taught a unit on science investigation. The PCK exhibited by the subject included proper utilization of activities that had been successfully used in previous units, and an understanding of the difficulties students commonly had in grasping the content. Most of the strategies the subject used were already a part of the teacher’s general pedagogy, and not science specific in nature. Anderson and Clark (2012) determined that the subject’s syntactic SMK formed the basis of the development of her PCK. The subject was able to develop new PCK by:

> Combining her general pedagogical knowledge with her syntactic SMK, for example in making success criteria explicit. The use of success criteria was part of her general pedagogical practice, but the nature of the criteria depended heavily on her syntactic science SMK, as did her assessment. (p. 328)

The findings of the study support the idea that PCK develops from a combination of other knowledge areas, but once fully formed it becomes its own knowledge domain from which teachers can draw. However, the researchers caution that limited participation in the scientific community may result in holes and misinterpretations in SMK (Anderson & Clark, 2012).

The Nature of Science

Not only must teachers have a solid understanding of the subject matter and pedagogy, they must also be able to transfer these understandings through their teaching practices so that students are able to conceptualize these new ideas (Shulman, 1987). In science disciplines, subject matter includes an understanding of the nature of science (Hanuscin, 2011). The nature of science (NOS) can be defined as the beliefs and values inherent to the development of scientific knowledge. It can also be referred to understanding science as a way of knowing (Lederman, 1992). NOS helps the average individual make sense of socio-scientific issues, be informed consumers of scientific information, and consider science as part of contemporary culture (Driver, Leach, Millar, & Scott, 1996, as cited in Hanuscin, 2011). The American Association for the Advancement of Science [AAAS] (1990, 1993), the National Research Council [NRC] (1996), and the National Science Teachers Association [NSTA] (2000) have all emphasized NOS as a critical component of scientific literacy in science education reform efforts. In its 2000 *Position Statement on the Nature of Science*, the NSTA focuses on seven aspects of NOS most common to science education reforms, specifically that (a) scientific knowledge is both reliable and tentative (subject to change in light of new evidence); (b) there is no single scientific method, but there are a shared set characteristics of scientific approaches to inquiry; (c) creativity is critical to the development of scientific knowledge; (d) there is a relationship between laws and theories; (e) there is a connection between observations and inferences; (f) there is always an element of subjectivity in the development of scientific knowledge; and (g) cultural and societal contexts play a role in scientific endeavors. Research by Hanuscin (2009) demonstrated that in order to effectively teach NOS, teachers must:

> Make aspects of NOS an explicit part of the classroom discourse. Teachers should provide learners with opportunities to reflect upon and explain their ideas about NOS, discuss the strengths and limitations of those ideas, and assess the consistency of their ideas with those of others. (p. 147)

In a 2000 study, Abd-El-Khalick and Lederman stated that teachers' PCK for NOS includes:

> Knowledge of a wide range of related examples, activities, illustrations, demonstrations, and historical episodes. These components would enable the teacher to organize, represent, and present the topic for instruction in a manner that makes the target aspects of NOS accessible to pre-college students. Moreover, knowledge of alternative ways of representing aspects of NOS would enable the teacher to adapt those aspects to the diverse interests and abilities of learners . . . . [T]eachers should be able to comfortably discourse about NOS, design science-based activities that would help students comprehend those aspects, and contextualize their teaching about NOS with some examples or "stories" from history of science. (p. 692–693).

According to Hanuscin (2009), PCK for NOS is formed from a combination of knowledge of science subject matter, knowledge of NOS, and knowledge of pedagogy. They also argue that in order to successfully teach NOS, teachers must have the knowledge base for teaching NOS, believe they can teach NOS, and must believe that students can learn NOS. The National Science Education Standards (NRC, 1996), state that effective teachers rarely implement lesson plans "as is", instead they select relevant science content and adapt their curriculum to meet the knowledge, abilities, understanding, interests, and experiences of students. Magnusson et al. (1999) emphasize that "teacher educators should be aware of the possibility that teachers may not have requisite knowledge of components not addressed by the program that would help them effectively use the knowledge they develop from the program" (p. 126). Hanuscin (2009) studied the PCK for NOS of three elementary school teachers, who successfully improved their students' understanding of NOS. The 3-year study used interviews, questionnaires, classroom observations, and classroom artifacts to measure PCK for NOS. Although each teacher had extensive knowledge of instructional strategies for teaching NOS, they lacked the "knowledge of assessment that would provide a feedback loop to support continued development of their knowledge of learners and lead to improvement in their teaching of NOS" (Hanuscin, 2009, p. 145). Based on the findings, professional development curriculum could be expanded to include helping teachers develop other aspects of PCK for NOS, rather than solely on helping teachers develop their skills for using particular instructional strategies (Hanuscin, 2009).

Based on this information, professional development curriculum needs to provide both instructional and assessment strategy scaffolds to teachers until they have developed a level of PCK sufficient to create and/or revise their own lesson plans (Hanuscin, 2009). This highlights the need for "educative curriculum materials" for NOS, or curriculum materials intended to promote both student and teacher learning (Davis & Krajcik, 2005). Educative curriculum materials can:

> Help teachers add important ideas to their repertoires, including SMK of NOS and students' likely ideas; however, such materials should remain flexible in promoting

> teachers' pedagogical design capacity, or their ability to use personal resources and supports embedded within curriculum materials to adapt curricula to meet the needs, interests, and abilities of their students. (Hanuscin, 2009, p. 164)

These materials would help teachers develop strategies to formatively and summatively assess students' NOS. An important component of teachers' PCK is knowledge of assessment, which provides them with crucial feedback on the effectiveness of their teaching and allows them to make adjustments to increase student understanding (Hanuscin, 2011). The NSTA's Standards for Science Teacher Preparation (NSTA, 2003, as cited in Hanuscin, 20011) encourages teachers to use assessment to guide and modify their instruction. Also, they should be able to "demonstrate that they are effective by successfully engaging students in the study of the nature of science" and that "assessments of effectiveness must include at least some demonstrably positive student outcomes" (NSTA, 2003, p. 17, as cited in Hanuscin, 2011). Davis and Krajcik (2005) emphasize that educative curriculum materials should be used to provide PCK support by enabling teachers to anticipate student misconceptions and to understand why students might arrive at these misconceptions. These materials should also provide suggestions that encourage teachers to challenge students through the use of analogies and alternative ways of representing ideas. This dynamic interaction would be transformative to both the teacher and the curriculum. While professional development workshops can and do serve as sources of PCK input, it is not until it is put into action that teachers' PCK actually takes form. Further development of science teacher PCK can be achieved by "equipping teachers with the necessary knowledge of assessment to close the feedback loop between teaching and learning" (Hanuscin, 2009, p. 165).

Educative curriculum materials can play a critical role in this process by supporting teachers in learning through their practice (Hanuscin, 2009).

The Relationship Between CK and PCK

In the field of science education, there are two areas of research that have been in the spotlight, one on content knowledge (CK) and the other on pedagogical content knowledge (PCK). Studies on CK focused mainly on the subject-specific knowledge of particular topics by methods such as concept mapping, free-recall technique, and semi-structured interviews. These studies revealed mostly the type of subject matter possessed by science teachers, *not* the kind required to teach a specific topic to students. In contrast, studies examining PCK concentrated on the nature of teachers' knowledge of pedagogy, instructional strategies, and of students' misconceptions using various methods such as semi-structured interviews, classroom observations, and questionnaire surveys (Zongyi, 2007). Despite this distinction between CK and PCK, research findings on their exclusivity are inconclusive. However, there is empirical evidence to suggest that CK may be a prerequisite for the development of PCK (Kleickmann et al., 2013). In a 2013 cross-sectional comparison study, Kleickmann et al. investigated PCK and CK at various points in the careers of pre- and in-service teachers. The results of the study revealed, "the largest differences in CK and PCK were found between the beginning and the end of initial teacher education" (Kleickmann et al., 2013, p. 90). This points to the importance of CK in the development of PCK. It can be concluded, "higher CK may lead to increased uptake of learning opportunities to acquire PCK, thus moderating the development of PCK" (Kleickmann et al., 2013, p. 91).

An additional hypothesis of the Kleickmann et al. (2013) study was that informal and formal learning opportunities are especially important to the development of both CK and PCK. Formal learning is mostly intentional, takes place in an institution, and the learner has the express goal of acquiring knowledge. In contrast, informal learning is mainly informal, has no set learning outcomes and takes place incidentally outside of an educational institution. Informal learning can also be referred to as learning by experience. Informal learning can occur through collaborating with peers, in teaching experiences, and even learning situations prior to formal teacher education. Formal learning occurs through teacher education programs and professional development (Kleickmann et al., 2013). Kleickmann et al. (2013) concluded that both formal and informal learning opportunities occurring during initial teacher education are critical to the development of subject matter knowledge. However, teaching experience produced only a weak development of subject matter knowledge. Therefore CK can be regarded as a prerequisite for the development of PCK. Recent studies have also provided strong evidence that subject-matter knowledge affects both teachers' instructional practices and student achievement gains (Kleickmann et al., 2013)

PCK and Teaching

In the 2002 "Secretary's Report on Teacher Quality", the United States Department of Education stated "rigorous research indicates that verbal ability and content knowledge are the most important attributes of highly qualified teachers. In addition, there is little evidence that education school coursework leads to improved student achievement" (as cited in Fantozzi, 2013, p.241). This report reflects the view that for secondary teachers, content knowledge is more important than pedagogical knowledge (Fantozzi, 2012). Additionally, in his 1986 analysis of the major programs in American educational research, Shulman stated that teaching content has not been given any serious attention. According to Doyle and Westbury (1992, as cited in Dijk, 2007), this inattention to the teaching content has resulted in a separation between curriculum and instruction. As a result, curriculum and instruction have become distinct fields within educational research. They also observe that while instruction research has been focused on measuring the effectiveness of teaching methods and teachers without paying regard to the subject being taught, curriculum research has been dealing mainly with implementation of curriculum and institutional level construction of curriculum. It is only on the classroom level that curriculum and instruction come together in the development of learning environments (Dijk, 2007).

As previously mentioned in this paper, PCK refers to specific topics, and therefore is different from general pedagogy knowledge. PCK also includes the teaching of specific topics, and therefore differs from subject matter knowledge (Van Driel et al., 1998). PCK is a unique domain that is influenced by numerous other knowledge areas. Therefore, Dijk (2007) proposes that a third element is included in PCK. This element, called “subject matter knowledge for teaching”, allows teachers to remain flexible in new and unanticipated situations. Also, because teaching experience is essential for PCK development, it can be assumed that beginning teachers usually possess little or no PCK. In 1990, Grossman (as cited in Dijk, 2007) conducted a study on six novice, but well prepared in subject matter, English teachers. Of the six participating teachers, three had completed professional coursework and three had no professional coursework experience. All teachers stated that they had learned most of what they know about student understanding from their personal teaching experiences. However, the teachers lacking professional training reported finding it difficult to assess students' prior knowledge. They used memories of their own grade school experiences to mold their expectations. Although through experience, they were able to learn with which topics students had difficulty, they were not able to understand why students found particular topics difficult, nor were they able to integrate this knowledge of student understanding into their teaching practices. Grossman (1990, as cited in Dijk, 2007) concluded that novice teachers can acquire a framework that shapes their learning from experience and through professional training. A 1999 review of literature by Magnusson et al., confirmed Grossman's results. They observed that, though there is limited research on science teachers' PCK of student understanding, the findings of these studies are consistent. ''Although teachers have some knowledge about students' difficulties, they commonly lack important knowledge necessary to help students overcome those difficulties'' (Magnusson et al., 1999, p. 106). An additional finding in the literature was that training is necessary for novice and experienced teachers to enable them to learn from their experiences.

This information implies that PCK is a type of knowledge that grows with increasing years of teaching experience, and is almost completely absent at the beginning of a teacher's career (Saeli, 2012). However, that does not imply that beginning teachers are incapable of teaching, but rather that they might not possess an 'armamentarium of representations' (Shulman, 2012). Thankfully, teacher training programs provide a framework for novice teachers to use to begin to build their PCK (Grossman, 1990, as cited in Lee & Luft, 2008). It is interesting to note that a completely different scenario presents itself when experienced teachers are required to teach a subject that is outside of their certification area. One study (Sanders, Borko, & Lockard, 1993) shows that when teaching a topic outside of their specialty area, veteran teachers sometimes acted like novice teachers. For example, they had difficulty answering student questions and determining the depth and extent to which a topic should be taught. These findings revealed that PCK knowledge is only somewhat transferable. Sometimes experienced teachers possessing strong PCK are able to successfully recycle their knowledge to teach subjects outside of their area of certification. Through their PCK, they are able to recognize the need to:

> Transform their knowledge for the students, even though there might be difficulty in determining how much to present at a given time and how to sequence their presentations. Through their PCK they can recognize the need to deal with students' input and try to determine students' background knowledge. (Saeli, 2012, p. 83)

Dijk (2007) developed a model to be used in the study of science teachers' PCK. This model, called educational reconstruction for teacher education (ERTE), represents an integrative approach to the study of PCK and aims to improve teacher education programs. The ERTE model is used to assess secondary teachers':

> (1) knowledge and beliefs of students' pre-scientific conceptions, (2) knowledge and beliefs of representations of the subject matter, and (3) 'subject matter knowledge for teaching', in relation to (a) the design of learning environments or teaching–learning sequences, (b) the study of students' pre-scientific conceptions, and in relation to (c) a subject matter analysis. (p. 885-886)

According to the model ERTE, in addition to deep understandings of subject matter, pedagogy, and context, prospective teachers also need to develop a framework that allows them to grow their PCK through learning experiences. This implies that teacher education programs should deliver this knowledge in a purposefully integrated manner. As a result, student teachers should be able to more quickly develop the skills and knowledge needed to become effective teachers (Dijk, 2007).

The ERTE model integrates the following research domains: (1) the design of learning environments, (2) the empirical study of students' pre-conceptions, (3) the analysis of the subject matter, (4) pedagogical content knowledge studies (PCK-S), and (5) the design of teacher education. All of these components are strongly interrelated and influence each other mutually. This model is the basis for an integrated approach to the study of science teachers' PCK. Within the ERTE framework, the teacher is an essential element in the design process of learning environments (Dijk, 2007).

Magnusson et al. (1999) designed a five component PCK model specifically for teaching science. The five components included in the model are, (a) orientations toward teaching science, which includes an appreciation for the general approaches to teaching science; (b) knowledge of students' understanding of science, including an awareness of needed student prerequisite knowledge and the difficulties students face when learning science topics; (c) knowledge of science curriculum, entailing a familiarity with science learning goals; (d) knowledge of instructional strategies used for teaching science, including insight into strategies for teaching science topics; and (e) knowledge of science assessments, including knowing how to assess the outcomes. For each of these components, teachers must develop PCK for both science topics and for scientific inquiry practices (Davis & Krajcik, 2005; Zembal-Saul & Dana, 2002). Teachers must learn to engage students in asking and answering scientific questions, exploring scientific phenomena, making predictions, collecting and analyzing data, and drawing conclusions based on evidence (National Research Council [NRC], 1996).

More thorough knowledge of a subject area allows teachers to better convey important concepts and a deeper meaning of their discipline. Recently, research focused on the area of history has been conducted to determine which methods and processes indicate PCK within the field. This has resulted in increased collaboration between historians and social studies educators. “The inclusion of historians in professional development of in-service teachers has ranged from content lectures to a more pedagogical focus in which historians and teachers exchange ideas on how to best teach history” (Fantozzi, 2012, p.242). This partnership has resulted in the funding of several national grants and the establishment of such institutions as the United States Department of Education's Teaching American History (TAH) program and the Gilder Lehrman Institute of American History. The aim of such programs is to connect history teachers with historians in hopes of immersing these teachers in the historiographical debates and disciplinary methods in the field. Fantozzi (2012) suggests that pairing an educator with a historian may be a critical missing component. Because of this, some teacher education programs have now begun to initiate collaborations with professional historians. Some of the strategies being used include situating the social studies education program within the history department, and having instructors from the history and education department co-teach courses. However, these innovative collaborations have produced only mixed results. While pre-service teachers in these programs did gain a deeper understanding of the nature of history, this understanding did not directly translate into altered pedagogical views. This study serves to highlight the idea that teacher educators and historians may have opposing views and goals in approaching a topic. Barton and Levstik (2004) point out that to teachers the purpose of teaching history is to focus on using classroom pedagogical practices to encourage students to become good citizens. In contrast, the primary objective for most historians is to interpret and reconstruct the past. In contrast, teacher educators are focused on sound pedagogical practice that can be enacted in the reality of the classroom (Fantozzi, 2012).

According to Beyer (2010):

> Just "knowing" something reflects a static view of PCK—an expression of teachers' ideas devoid of a particular context or situation. For example, teachers may have ideas about the typical difficulties students face with a particular topic or useful strategies or representations for teaching particular areas. However, "using" knowledge entails a more dynamic view of PCK, where teachers flexibly apply their knowledge to a particular task. From this perspective, teachers engage in complex reasoning processes. These may include selectively retrieving knowledge they think is most relevant and using that knowledge in flexible ways to address a particular situation. (p. 132)

When teachers use their PCK in the classroom, they must combine their knowledge in new and different ways, which results in new knowledge development (Beyer, 2010). PCK must be flexible to a wide range of pedagogical activities included in both teaching and planning of classroom activities (Ball & Bass, 2000). The study conducted by Beyer (2010) also highlights specific areas in which teacher educators can assist beginning teachers in identifying and addressing gaps in their knowledge. Such areas include student teachers' understanding of science curriculum and assessments, subject-specific instructional strategies, and scientific inquiry. By targeting these areas, teacher educators can help novice teachers to:

> Develop greater capacities in applying their PCK in the analysis of science lesson plans. In turn, they may be better positioned to identify the strengths and weaknesses within curriculum-based lessons and make modifications that meet the ambitious goals entailed in reform-oriented science teaching. (Beyer, 2010, p. 153)

Teacher Education

One of the main problems with teacher education programs is that student teachers are often disillusioned and disappointed with their teacher education programs (Korthagen, 2001). They expect to be instructed on how to teach, but are instead bombarded with an array of teaching issues that do not directly translate into how to conduct a lesson. "Although student-teachers 'generally value the practice teaching component [of their teacher education program], there is almost a universal dissatisfaction … with 'educational theory' courses provided by universities" (Skilbeck & Connell, 2005, p. 6, as cited in Loughran, 2008). Thus, PCK could be regarded as a component of such 'educational theory' (Loughran, Mulhall, & Berry, 2008).
In secondary science education, researchers argue that graduate students entering teacher education courses are blind to the learning challenges that lie ahead of them and often do not realize the demands that teaching will make on them (Loughran, Mulhall, & Berry, 2008). Thus, novice teachers may not fully comprehend that effective teaching is a purposeful activity that involves complex processes of pedagogical reasoning (Williams, 2012). Research has identified three common factors contributing to the growth of PCK in beginning teachers (Kind, 2009). First, they must possess extensive subject matter knowledge; second, they need classroom experience, with studies indicating that significant changes occur in the early years of teaching;

and third, they should possess the emotional attributes of such as personal self-confidence, and the ability to collaborate with other teachers (Kind, 2009).

For many student teachers, the link between the actual practice of teaching and the theories being presented in teacher education programs seems to be missing. Whereas student teachers consider the process of learning to teach as acquiring teaching skills and a repertoire of activities, and good teaching to consist of classroom management skills and activities that facilitate student learning, their teacher education professors consider it just as important for them to contemplate a wide range of complex educational issues that on the surface may not seem particularly useful in the classroom. Part of the reason for this disconnect appears to be the fact that many student teachers tend to underestimate or dismiss the cognitive aspects of teaching. As grade school students, they were not privy to the thinking and decision-making processes of their teachers (Munby, Russell, & Martin, 2001, as cited in Loughran et al., 2008). As novice teachers, other problems come to light as they talk to and observe the practices of veteran teachers. These more experienced teachers may be unintentionally reinforcing the preconception of teaching as routines that must be learned and performed. The majority of teacher knowledge is implied and contextual, and because teachers lack a formal language for sharing their thoughts and have inadequate time to reflect on their practices, they are often unable to satisfactorily explain adequately to younger teachers the why and the what of their teaching practices (Loughran, et al., 2008).

The intertwined nature of PCK and subject matter knowledge creates problems for teacher educators. Studies suggest that often science student teachers lack a deeper conceptual understanding of the content they will be teaching, and that their "subject matter knowledge is fragmented, compartmentalized, and poorly organized, making it difficult to access this knowledge efficiently when teaching" (Gess-Newsome, 1999, p. 63, as cited in Loughran et al., 2008). These struggles, including those with the nature of science and scientific inquiry, are significant hurdles that new teachers must overcome. As science knowledge and technological development rapidly increase, it is imperative that teacher education programs create new strategies that will enable teachers to develop PCK about pedagogical challenges that should support success for learners in the twenty-first century (Williams, 2012). Additionally, while history majors may have mastered factual knowledge, they may not truly comprehend the underlying concepts, processes, and ideas that are a requirement for true inquiry-based instruction. Furthermore, even with mastery of advanced inquiry-based methods, teachers may not necessarily alter their instructional methods (Fantozzi, 2012). For example, in a 2010 case study of a high school teacher, Van Sledright found that a Ph.D. in history and a deep knowledge of the discipline did not transform her teaching practices.

In a 2006 study, Johnston and Ahtee stated that a link exists between student teachers' attitudes and confidence in physics teaching, and that both were reinforced through good PCK and subject matter knowledge. Lederman and Gess-Newsome (2003 as cited in Loughran et al., 2008) argued that student teachers develop their goals around issues, such as classroom management, that are very far removed from the complexities associated with constructing PCK. They also noted a "relative absence of concerns related to subject matter" (Lederman & Gess-Newsome, 2003, p. 202 as cited in Loughran et al., 2008). In order to remedy this, they suggest that student teachers be provided time to reflect on and develop their understanding of science knowledge, as well as opportunities to apply these understandings to classroom practices. In a study to establish the CK and PCK of secondary mathematics teachers, Kruass, Brunner, et al. (2008) concluded that the structure of subject matter knowledge is inconsistent between various teacher populations. For example, pre-and in-service teachers often display fragmented knowledge and misconceptions of subject matter concepts, which limits their ability to respond appropriately to student conceptions and to create “cognitively challenging learning situations” (Kleickmann et al., 2013, p. 92). Given the emphasis placed on teacher knowledge and student achievement, teacher education is the driving force for educational reform. However, the effect of teacher education programs on the development of PCK remains largely under researched. One of the key challenges lies in how to accurately assess teacher knowledge. Only recently have test instruments been developed to gauge the components of teacher knowledge (Kleickmann et al., 2013). One such study that makes use of these tests is the study of German pre- and in-service mathematics teachers conducted by Kleickmann et al. (2013). Specifically, the study examined how learning opportunities “available during teacher education and professional development affect the development of subject-specific knowledge” (Kleickmann et al., 2013, p. 94). The results showed that future academic track teachers, who are exposed to many more formal CK learning opportunities, produced consistently higher gains in CK than future non-academic track teachers. Also, the in-service phase of the teacher education program did not foster as much development of CK and PCK as did the initial portion of the teacher education program (Kleickmann et al., 2013).

Research states that teachers not possessing the adequate CK required to teach the subject matter is an ever increasing problem. A possible solution to this problem is professional development activities aimed at negating these deficiencies. For example, professional development for pre-service teachers should emphasize coursework that builds a strong ability for teaching the subject matter (Ojose, 2012). There is also research that indicates “effective professional development that affected teacher learning, instruction, and student progress consisted of long-term and coherent programs that involved teachers in active learning, and that had a clear focus on content and student learning” (Darling-Hammond et al., 2009, as cited in Ojose, 2012, p.163). Another way to effectively develop teacher expertise could be to study the various ways of teaching topics central to the content area. Jyväskylä University in Finland uses just such an approach in their primary level science education program. In this program, student teachers make a one yearlong study of the teaching of one specific science topic. Most of the coursework is in support of this project. Student teachers are given as many opportunities as possible to test out their ideas and lesson plans at the training school located on the university’s campus. Included in this project is analyzing content, finding out students’ feelings about the topic, selecting and creating the most appropriate teaching strategies, and planning lessons for a period of actual teaching (Kapyla, 2009).

According to Shulman (1987), PCK is what allows the transformation of disciplinary content into forms that are attainable by students. This includes knowledge of how the organization of particular subject matter topics, problems, and issues can be adapted to fit the diverse abilities of students. It is representative of the

> Synthesis of teachers’ knowledge of both subject matter and pedagogy, distinguishing the teacher from the content specialist. The development of PCK involves a dramatic shift in teachers’ understanding from being able to comprehend subject matter for themselves, to becoming able to elucidate subject matter in new ways, reorganize and partition it, clothe

> it in activities and emotions, in metaphors and exercises, and in examples and demonstrations, so that it can be grasped by students. (Shulman, 1987, p. 13)

Abell (2008) proposes that teacher knowledge begins with generalized pedagogical knowledge and odd bits of PCK and then gradually moves toward a PCK that is more integrative. So, it seems logical that science teachers use a combination of topic-specific knowledge, discipline-specific knowledge, and general science PCK to enhance student learning (Abell, 2008). Therefore, learning to teach science is not only about acquiring a repertoire of general pedagogical-based strategies; rather it is about “developing a complex and contextualized set of knowledge to apply to specific problems of practice” (Abell, 2008, p. 1414). PCK allows teachers to recognize that the knowledge needed to successfully teach science is vastly different from the knowledge needed to teach other academic subjects. What makes PCK so valuable is that it tells teachers about learning to teach science, which ultimately affects how our students learn science (Abell, 2008). While PCK has vast potential in teacher education programs, these programs are lacking methods with which to analyze and represent the knowledge. These methods should be “simple enough to guide the practice, yet help to grasp rapidly the idea and give simple conceptual tools for lesson planning” (Kapyla, 2009, p. 1410).

Albert Bandura’s social cognitive theory states that “perceptions of the self mediate human behavior; individuals confer meaning and weight to the happenings in their environment through the filter of their beliefs about themselves” (Soodak, Podell, & Lehman, 1998, p.481). A major component of the social cognitive theory is self-efficacy, which refers to “beliefs in one’s capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet situational demands” (Wood & Bandura, 1989, p.408, as cited in Harrison Rainer, Hochwarter,

& Thompson, 1997, p. 80). According to the social cognitive theory, self-efficacy has two parts: Efficacy expectation and outcome expectancy (Gavora 2010).

Efficacy Expectation

Gavora (2010) defines efficacy expectation as the belief that one has the knowledge, skills, and ability to successfully complete the behavior or action required to obtain the desired outcome.

Outcome Expectancy

Outcome expectancy is an individual's estimation of the likely impact of performing a task at the expected level of performance. In other words, outcome expectancy is a "belief that a given behavior or action will lead to the expected outcome(s)" (Gavora, 2010, p. 19). A successful teacher must possess both high outcome expectancy and high efficacy expectations. "If a teacher has the former and not the latter, it is unlikely that he/she will be a successful teacher even if he/she is professionally well-qualified" (Gavora, 2010, p. 19).

Despite contemporary concerns that education majors are less well prepared in their subject areas than are academic majors, studies comparing teachers with degrees in education and those with degrees in subject area fields have failed to find a correlation between degree type and teacher performance (Murnane, 1985). One reason for this may be the fact that "certification requirements reduce the variability in course backgrounds found for teachers with different degree types" (Darling-Hammond, 2000, p.4). For example, as part of the education degree for high school teachers, some states require the equivalent of an academic major in the subject to be taught, regardless of the department granting the degree (NASDTEC, 1997). Because of the standardizing influences of licensing requirements within states, but differing licensing requirements across states, within-state studies will find less variation in teachers' education backgrounds than in cross-state studies (Darling-Hammond, 2000).

Teacher Certification

"According to the National Commission for Teaching and America's Future (NCTAF), more new teachers will be hired in the next decade than in any previous decade in our history" (NCTAF, 1996, p. 76, as cited by Goldhaber & Brewer, 2000). Research suggests that factors such as class size (Mosteller, 1995), teacher qualifications (Ferguson, 1991), and other school variables may play an important role in what students learn. As a result of NCLB, new standards for student achievement have been introduced in states across the country, and greater attention has been placed on the role of teacher quality on student learning (National Commission on Teaching and America's Future, 1996). In fact, more than 25 states have recently adopted legislation to improve recruitment, education, certification, and professional development of teachers (Darling-Hammond, 1997). Teacher licensure intends to guarantee a basic level of quality of teachers in public schools (Goldhaber & Hansen, 2010). According to Epstein and Miller (2011), teacher-licensing requirements are the responsibility of state boards of education and state legislatures. However:

> Certification always involves exams, often in both general knowledge and teaching skills, and it nearly always involves coursework and practice teaching. Ideally certification keeps poor teachers out of the classroom, while giving people with the potential to be good teachers the skills and experience they need to do their jobs well. (Boyd et al., 2007)

NCLB calls for the “hiring of only ’highly qualified’ teachers on the basis of teacher background characteristics” (U.S. Department of Education, 2004, as cited by Huang & Moon, 2009). According to the legislation, new teachers are considered highly qualified if they “receive state certification and demonstrate content knowledge of the material they teach, either by passing a subject-area exam or by having an undergraduate major in that subject, or both” (Boyd et al., 2007). Veteran teachers may satisfy NCLB requirements by passing subject-area exams (Boyd et al., 2007).

There is some evidence to suggest that more qualified teachers may make a difference for student learning at the classroom, school, and district levels, but there has been little inquiry into the effects on achievement that may be associated with large-scale policies and institutional practices that affect the overall level of teachers' knowledge and skills in a state or region (Darling-Hammond, 2000). While NCLB set minimum requirements for all teachers in the United States, the actual licensing standards and the enforcement of these standards vary from state to state. For example, in Minnesota, a prospective high school teacher must complete a bachelor's degree in education and additional coursework including learning theory, child development, teaching methods, curriculum, teaching strategies, technology integration, classroom management, behavior and motivation, and the education of students with special needs. During this same time period, the prospective teacher must also complete student teaching under the supervision of a cooperating teacher (Minnesota Department of Education, n.d.). In contrast, in the state of Alabama, prospective high school teachers can become licensed with a bachelor’s degree in any area. New teachers are required to study curriculum, teaching strategies, classroom management, technology, or the needs of special education students as part of a teacher certification program that includes a period of student teaching and observation (Alabama State Department of Education, n.d.). Not only do the standards themselves differ, there are differences in the enforcement. While some states do not allow school districts to hire unqualified teachers, other districts regularly allow the hiring of teachers who do meet the standards, even when qualified teachers are available. In 1994, twelve states, including Wisconsin, did not hire any elementary or secondary teachers who were not licensed in their field. By contrast, "in Louisiana, 31% of new entrants were unlicensed and another 15% were hired on substandard licenses. At least six other states allowed 20% or more of new public school teachers to be hired without a license in their field" (Darling-Hammond, 2000, p.10).

In every area in which standards for teaching are set (licensing, advanced certification), there are vast differences in the policies and practices employed across the states. Some of the highest, most consistently enforced standards for teachers tend to occur in the upper Midwest states (Minnesota, Wisconsin, Iowa, Nebraska, North Dakota, Missouri, Montana, and Kansas). On the opposite end of the spectrum, the states with the lowest and least enforced standards are located in the southeast (Louisiana, Mississippi, Georgia, and South Carolina). While some states have developed ambitious standards for teaching, they fail to enforce them for many of the candidates (e.g. California, New York). Other states have recently invested large amounts of time and money in pre-service and in-service teacher development that have benefited a substantial share of the teachers (e.g., Connecticut, Kentucky, North Carolina, West Virginia) (Darling-Hammond, 2000). In conclusion, Darling-Hammond (2000) states, "teacher quality characteristics such as certification status and degree in the field to be taught are very significantly and positively correlated with student outcomes" (p.23).

Teacher Efficacy

Teacher self-efficacy is defined as a teacher's belief in his/her ability to affect student outcomes (Tournaki et al., 2009). A teacher's sense of self-efficacy influences "such behaviors as (a) helping struggling students arrive at correct answers rather than simply providing the correct answers (Allinder, 1994); (b) employing strategies that minimize negative affect (Ashton & Webb, 1986, as cited in Long & Moore, 2008); (c) constructing classroom environments characterized by warm interpersonal relationships and academic work; (d) using activity-based, student-centered learning (Enochs, Scharmann, & Riggs, 1995); and (e) implementing more humanistic approaches to pupil control" (Long & Moore, 2008, p. 445). Corkette et al. (2011) states that teachers with high self-efficacy:

> Influence student achievement because they are more likely to learn and implement new teaching approaches and strategies, use positive management strategies, provide assistance to low achieving students, increase student academic self-efficacy, set attainable goals for their students and persist when faced with student failure. (p. 72)

Tournaki et al. (2009) concludes, "teachers who believe that they are effective set more challenging goals for themselves and their students, take responsibility for student outcomes, and persist when faced with obstacles to learning" (p. 99).

According to the social cognitive theory, high teacher efficacy is developed from four sources: Mastery learning experiences, vicarious experiences, social persuasion, and physiological and emotional states (Gavora, 2010).

Mastery Teaching Experiences

Mastery teaching experiences are situations in which teachers demonstrate their personal teaching successes. "Enacted mastery (teaching) experiences are the most influential source of [self-] efficacy information because they provide the most authentic evidence of whether one can muster whatever it takes to succeed" (Bandura, 1997, p.80, as cited in Gavora, 2010, p. 19). When teachers engage in teaching, they interpret their results and use those interpretations to develop their beliefs about their teaching success. If these teaching activities are successful, they will raise self-efficacy, or if these experiences are failures, self-efficacy will be lowered (Gavora, 2010).

Vicarious experiences. Vicarious experiences are defined as "learning from observation of the successes of other teachers" (Gavora, 2010, p. 19). Teachers can learn to be more effective by observing and modeling effective behaviors exhibited by colleagues (Gavora, 2010).

Social persuasion. A teacher's self-efficacy can be enhanced by the social persuasion of supervisors and colleagues. Actions such as coaching and providing positive feedback are commonly used to positively influence teachers' self-efficacy. "Essentially, emotional support builds the teacher's belief in teaching self-efficacy" (Gavora, 2010, p. 20).

Physiological and emotional states. "The teacher who is professionally well-qualified may not be a successful teacher if his/her personal negative or inhibiting emotional factors come into play" (Gavora, 2010, p. 20). Thus the physiological and emotional states of the teacher may influence self-efficacy judgments. A teacher's enthusiasm can provide insight about anticipated teaching success. Conversely, negative feelings such as anxiety and stress can lead to a negative judgment of teaching ability (Gavora, 2010).

Impact of Teacher Efficacy on Students

In general, teachers who possess high self-efficacy are more likely to approach teaching in creative and innovative ways. They are also more willing to take responsibility for the outcomes of their actions (Tournaki et al., 2009). Corkette et al. (2011) report that teachers with high self-efficacy "work harder and persist longer when teaching difficult students, in part because of the teachers' belief in their teaching abilities and because of their belief in the students' abilities" (p. 72). Finally, there is a link "between teacher self-efficacy and student achievement in reading and writing where teachers with high self-efficacy own the responsibility of teaching all children and those with low self-efficacy attribute problems to the students" (Corkette et al., 2011, p. 72).

Self-efficacy is a major component of Bandura's social cognitive theory and refers to an individual's confidence for engaging in activities that lead to the fulfillment of specific goals (Erlich & Russ-Eft, 2011). "From an educational perspective, such beliefs certainly impact a student's educational performance" (Pajares, 1996). Bandura also suggests that mastery experiences, vicarious experiences, social persuasion, and physiological and emotional states influence the development of teacher self-efficacy (as cited in Long & Moore, 2008). Research suggests that teachers possessing high self-efficacy set challenging goals for themselves and their students, persist when faced with learning obstacles, and take responsibility for student outcomes (Tournaki et al., 2009). Therefore, teachers who earned more subject-area content credit hours in college should possess a more thorough and complete understanding of the content they teach and have a stronger sense of efficacy than a teacher who earned fewer subject-area content credit hours.

CHAPTER THREE: METHODOLOGY

Introduction

Considerable research has identified teacher quality as the most important indicator of student achievement. Researchers have estimated that "variations in teacher quality explain between 7.5% and 8.5% of the total variation in student achievement" (Goldhaber et al., 1999; Rivkin et al., 2005). However, evidence shows that there is no clear consensus on the importance of teachers' educational attainment and experience that makes a good teacher (Luschei & Chudgar, 2011).

One of the most consistent finds from the literature is that teachers' test scores and other measures of teacher knowledge do have a positive effect on student achievement (Ferguson, 1991; Goldhaber & Brewer, 2000; Monk, 1994). There is also recent evidence to suggest that teachers' knowledge of the subject positively contributes to students' academic achievement (Hill et al., 2005). However, Hill (2007) has found that in the United States, teachers with higher content-specific knowledge tend to be distributed unequally, with more highly qualified teachers working with children from higher socioeconomic areas. There has also been minimal research on the effects of teacher PCK on student achievement on standardized tests. The purpose of this correlational study was to determine if there was a relationship between the number of subject-area content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests.

Design

This study used primarily quantitative measures to collect and analyze data. The use of a correlational research design for this study permitted predictive relationships among variables to be observed and measured. According to Gall, Gall, and Borg (2002), a bivariate correlational design was used to determine the degree of relationship between two variables. This design also supported the researcher's efforts in determining whether positive or negative relationships existed between student achievement on standardized tests and the number of subject-area content credit hours earned by high school teachers.

Research Questions

The research questions for this study were**:**

RQ1: Is there a correlation between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT?

RQ2: Is there a correlation between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra EOCT and the Analytic Geometry EOCT?

RQ3: Is there a correlation between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT?

RQ4: Is there a correlation between the number of college-level English literature content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT?

RQ5: Is there a correlation between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests?

Null Hypotheses

Alternatively, the following were the null hypotheses:

$H_0$1: There will be no correlation between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT.

$H_0$2: There will be no correlation between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra EOCT and the Analytic Geometry EOCT.

$H_0$3: There will be no correlation between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT.

$H_0$4: There will be no correlation between the number of college-level English literature content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT.

$H_0$5: There will be no correlation between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests.

Participants and Setting

A voluntary response survey sample was used in this study. Participants consisted of EOCT course teachers from two public high schools located in north Georgia. Teacher participants were selected by the researcher based on the EOCT subject(s) they taught (Biology, Physical Science, Coordinate Algebra, Analytic Geometry, U.S. History, Economics, 9th Grade Literature, or American Literature). Student achievement was measured by the percentage of students scoring at the Meets or Exceeds level on the cumulative standardized End Of Course Tests (ECOT) typically taken by students in the 9th through 12th grades. The students were enrolled in EOCT courses taught by the teachers participating in the study. Some of the classes were honors level and others were on-level courses. Because enrollment in honors courses was voluntary, students in honors-level courses may be identified gifted while others are not. Additionally, the classes may also have contained special needs students and English Language Learner (ELL) students. Teacher data including college-level subject-area content hours earned, years of teaching experience, degree(s) held, and EOCT subject(s) taught was gathered from a voluntary online survey. Student data was historical, and no students were identified throughout the study.

The setting included 2 high schools located in north Georgia. Both of the high schools are considered to be rural and are the only high school in their respective counties. Both schools are located in the northern portion of Georgia. They have student enrollment between 800-1000. Additionally, both of the high schools have similar socioeconomic status and racial distribution (Appendix A).

Instrumentation

Teacher information was gathered using a researcher-made survey via surveymonkey.com. This is a free online survey and questionnaire tool that allowed the researcher to view the results graphically and in real time (SurveyMonkey, 2014). Information gathered by the survey included: Number of college-level content-area credit hours earned, years of teaching experience, degree(s) held, and EOCT subject(s) taught (Appendix D).

Student achievement was measured by the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests. The EOCTs are standardized achievement tests designed by the Georgia Department of Education that are aligned with the Georgia curriculum standards and include the assessment of specific content knowledge and skills. The tests provide data to evaluate student strengths and areas of needed improvement. The tests are scored on a 100-point scale ranging from “exceeds” to “does not meet”. A score of 90% or higher is designated as “exceeds”, a score between 89%-70% is “meets”, and a score of 69% or below “does not meet” (EOCT, 2013).

Validity and reliability data for the EOCTs was provided by the Testing and Assessment Division of the Georgia Department of Education (EOCT, 2013). In order to assure validity, a clear purpose is provided for the tests. According to the Georgia Department of Education (GaDOE), the purpose of the statewide standardized testing program is to (a) measure student progress toward mastery of the Georgia Performance Standards (GPS); (b) identify at-risk students; (c) provide data and analyses to guide instructional decisions; and (d) identify strengths and weaknesses for use in educational planning at the school level (EOCT, 2013).

Validity is also ensured in the development of the EOCTs. Test development begins with aligning the curriculum and identifying content descriptors to be tested. Committees composed of content area specialists, professional test designers, and Georgia educators work together to create the test items. New test items are field tested by being embedded in the current operational versions of the EOCT. Then, the test development committee must approve or reject the field test items for future test forms of the EOCT. Multiple forms of each EOCT are developed by content specialists and psychometricians. These different forms are used in the same year or in subsequent test administrations and are statistically equated to make sure each form of the test is of equal difficulty level (EOCT, 2013).

The spring 2013 EOCT administration, which was composed of block scheduled and full year students, had a range of coefficients for all tests that fell between .74 and .94, indicating a high degree of reliability. A standard error of measurement (SEM) was used to measure test precision on the two forms of the spring 2013 EOCTs. The SEM values ranged from 3.26 to 3.63 for the spring 2013 administration (Appendix E). This indicated a high level of reliability. GaDOE addressed validity in item and test development and EOCT administration. This provided adequate statistical data to establish reliability.

Procedures

Prior to the start of data collection, the researcher obtained approval from the Liberty University Institutional Review Board (IRB) to conduct the study (Appendix H) and then secured permission from the superintendents and principals of the participating schools (Appendices C & D). Next, the researcher contacted the principals of each of the high schools included in the study to obtain the names and email address of all EOCT course teachers. The researcher then sent an email containing an Informed Consent Form (Appendix F) to all of the above-mentioned teachers. Once the researcher obtained the consent of all those participating in the study, each participant was assigned a number in order to protect individual identities. An administrator from each of the participating high schools was contacted to provide the researcher with the 2012-2013 End of Course Test (EOCT) results for all courses. This report contains the percentage of students who scored Meets or Exceeds for each teacher participating in the study. This data was compiled into a Microsoft Excel spreadsheet. Next, the researcher created a survey via Surveymonkey.com to gather teacher information on degree(s) held, years of teaching experience, subject(s) taught (Biology, Physical Science, Coordinate Algebra, Analytic Geometry, U.S. History, Economics, 9th Grade Literature, or American Literature), and the total number of subject-area content college credit hours earned. An email containing a link to the online survey was sent to all study participants (Appendix G). Data gathered from the survey was grouped and entered into a Microsoft Excel spreadsheet. This data and the data gathered from the school administrators were combined and transferred into SPSS to run statistical analyses.

Data Analysis

Descriptive and correlational methods were used to describe the relationships between the variables used in the study. First, the researcher performed all basic descriptive analysis tests. A bivariate correlational analysis using the Pearson Product Moment Correlation method was then utilized to determine if the variable (number of subject-area content credit hours) is a significant predictor of student achievement on Georgia EOCTs. The Pearson coefficient allowed the researcher to determine the strength of the relationship between teacher degree type and student achievement (Gall, Gall, & Borg, 2002).

CHAPTER FOUR: FINDINGS

Introduction

The purpose of this correlational study was to determine if there was a relationship between the number of college subject-area content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests in Biology, Physical Science, American Literature, 9th grade Literature, Coordinate Algebra, Analytic Geometry, United States History, and Economics. The study used pre-existing EOCT data from the 2012-2013 school year. The participating teachers took the demographic survey more recently. The students who took the EOCTs were from two small, rural high schools where over 45% of students received free-or reduced-price lunch. The data were compared to the number of college subject-area content credit hours earned by the teachers whose students' scores were used. The teachers were mostly female and all held a minimum of a bachelor's degree and a valid Georgia teaching certificate. All correlation values were calculated using a .05 level of significance. As stated in previous sections, this study sought to answer the question: Is there a relationship between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests?

Research Questions

The research questions for this study are**:**

RQ1: Is there a correlation between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT?

RQ2: Is there a correlation between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra EOCT and the Analytic Geometry EOCT?

RQ3: Is there a correlation between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT?

RQ4: Is there a correlation between the number of college-level English literature content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT?

RQ5: Is there a correlation between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests?

Descriptive Statistics

The number of college subject-area content credit hours for each teacher was correlated with percentage of students scoring at the Meets or Exceeds level for that teacher in each academic area and all together. Pearson's correlation test was used to find this relationship. A two-tailed p-value is presented in each table along with r.

Results

Null Hypothesis One

A Pearson product-moment correlation was used to evaluate the null hypothesis that there will be no correlation between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT. A critical vale of r=.497 was used to determine level of significance. There was no significant evidence (Table 1). The researcher failed to reject the null hypothesis and concluded that there was no correlation between the number of college-level science content credit hours earned by teachers (M=2.56, SD=0.89) and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT (M=83.94, SD=13.19), r=-0.31, p=0.23. Higher amounts of college-level science content credit hours were not associated with a higher percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT.

Table 1: *Summary of science correlation statistics*

Teachers	**Subject-area Credit Hours**	**Percent Meeting or Exceeding**	**Teachers**	**Subject-area Credit Hours**	**Percent Meeting or Exceeding**
Teacher 2	20-30	82	Teacher 31	>30	100
Teacher 6	>30	82	Teacher 33	>30	53
Teacher 8	>30	71	Teacher 36	10-20	100
Teacher 11	>30	81	Teacher 37	>30	73
Teacher 18	>30	100	Teacher 43	>30	79
Teacher 19	>30	100	Teacher 47	>30	78
Teacher 22	>30	92	Teacher 49	>30	81
Teacher 25	20-30	76	Teacher 45	<10	95
			P-value: 0.23		
			r: -0.31		

Null Hypothesis Two

A separate Pearson product-moment correlation was used to evaluate the null hypothesis that there will be no correlation between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra EOCT and the Analytic Geometry EOCT. A critical vale of r=.456 was used to determine level of significance. There was no significant evidence (Table 2). The researcher failed to reject the null hypothesis and concluded that there was no correlation between the number of college-level mathematics content credit hours earned by teachers (M=1.95, SD=1.18) and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra EOCT and the Analytic Geometry EOCT (M=44.11, SD=31.06), r=-0.39, p=0.09. Higher amounts of college-level math content credit hours were not associated with a higher percentage of students scoring at the Meets or Exceeds level on the Coordinate Algebra EOCT and the Analytic Geometry EOCT.

Table 2: *Summary of mathematics correlation statistics*

Teachers	**Subject-area Credit Hours**	**Percent Meeting or Exceeding**	**Teachers**	**Subject-area Credit Hours**	**Percent Meeting or Exceeding**
Teacher 3	>30	24	Teacher 35	<10	100
Teacher 4	>30	46	Teacher 40	>30	26
Teacher 7	>30	0	Teacher 41	<10	30
Teacher 9	20-30	35	Teacher 42	10-20	30
Teacher 10	>30	19	Teacher 44	>30	40
Teacher 12	10-20	11	Teacher 45	<10	95
Teacher 20	10-20	92	Teacher 48	10-20	43
Teacher 24	20-30	11	Teacher 50	>30	63
Teacher 29	>30	87	Teacher 51	20-30	67
Teacher 32	>30	19	**P-value: 0.097**		
			r: -0.39		

Null Hypothesis Three

A Pearson product-moment correlation was used to evaluate the null hypothesis that there will be no correlation between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT. A critical vale of $r=.707$ was used to determine level of significance. There was no significant evidence (Table 3). The researcher failed to reject the null hypothesis and concluded that there was no correlation between the number of college-level social studies content credit hours earned by teachers ($M=2.00$, $SD=0.93$) and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT ($M=85.63$, $SD=9.59$), $r=-0.01$, $p=0.97$. Higher amounts of college-level social studies content credit hours were not associated with a higher percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT.

Table 3: *Summary of social studies correlation statistics*

Teachers	**Subject-area Credit Hours**	**Percent Meeting or Exceeding**
Teacher 13	20-30	85
Teacher 14	20-30	93
Teacher 21	20-30	87
Teacher 26	<10	90
Teacher 30	>30	100
Teacher 34	>30	79
Teacher 38	20-30	68
Teacher 52	20-30	83
P-value: 0.97		
r: -0.01		

Null Hypothesis Four

Another Pearson product-moment correlation was used to evaluate the null hypothesis that there will be no correlation between the number of college-level English content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT. A critical vale of r=.602 was used to determine level of significance. There was no significant evidence (Table 4). The researcher failed to reject the null hypothesis and concluded that there was no correlation between the number of college-level English content credit hours earned by teachers (M=2.09, SD=1.04) and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT (M=81.27, SD=21.14), r=0.35, p=0.29. Higher amounts of college-level English content credit hours were not associated with a higher percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT.

Table 4: *Summary of English correlation statistics*

Teachers	**Subject-area Credit Hours**	**Percent Meeting or Exceeding**
Teacher 1	20-30	94
Teacher 5	20-30	88
Teacher 15	10-20	50
Teacher 16	>30	96
Teacher 17	10-20	33
Teacher 23	20-30	87
Teacher 27	>30	75
Teacher 28	>30	87
Teacher 29	>30	87
Teacher 39	>30	97
Teacher 46	<10	100
P-value: 0.29 **r: 0.35**		

Null Hypothesis Five

A final Pearson product-moment correlation was used to evaluate the null hypothesis that there will be no correlation between the number of college-level subject-specific content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia EOCTs. A critical vale of r=.273 was used to determine level of significance. There was no significant evidence (Table 5). The researcher failed to reject the null hypothesis and concluded that there was no correlation between the number of college-level subject-specific content credit hours earned by teachers (M=2.19, SD=1.01) and the percentage of students scoring at the Meets or Exceeds level on the Georgia EOCTs (M=68.79, SD=29.13), r=-0.02, p=0.89. Higher amounts of college-level subject-specific content credit hours were not associated with a higher percentage of students scoring at the Meets or Exceeds level on the Georgia EOCTs.

Table 5: *Summary of all academic areas correlational statistics*

Teachers	Subject-area Credit Hours	Percent Meeting or Exceeding	Teachers	Subject-area Credit Hours	Percent Meeting or Exceeding
Teacher 1	20-30	94	Teacher 28	>30	87
Teacher 2	20-30	82	Teacher 29	>30	87
Teacher 3	>30	24	Teacher 30	>30	100
Teacher 4	>30	46	Teacher 31	>30	100
Teacher 5	20-30	88	Teacher 32	>30	19
Teacher 6	>30	82	Teacher 33	>30	53
Teacher 7	>30	0	Teacher 34	>30	79
Teacher 8	>30	71	Teacher 35	<10	100
Teacher 9	20-30	35	Teacher 36	10-20	100
Teacher 10	>30	19	Teacher 37	>30	73
Teacher 11	>30	81	Teacher 38	20-30	68
Teacher 12	10-20	11	Teacher 39	>30	97
Teacher 13	20-30	85	Teacher 40	>30	26
Teacher 14	20-30	93	Teacher 41	<10	30
Teacher 15	10-20	50	Teacher 42	10-20	30
Teacher 16	>30	96	Teacher 43	>30	79
Teacher 17	10-20	33	Teacher 44	>30	40
Teacher 18	>30	100	Teacher 45	<10	95
Teacher 19	>30	100	Teacher 46	<10	100
Teacher 20	10-20	92	Teacher 47	>30	78
Teacher 21	20-30	87	Teacher 48	10-20	43
Teacher 22	>30	92	Teacher 49	>30	80
Teacher 23	20-30	87	Teacher 50	>30	63
Teacher 24	20-30	11	Teacher 51	20-30	67
Teacher 25	20-30	76	Teacher 52	20-30	83
Teacher 26	<10	90	**P-value: 0.89**		
Teacher 27	>30	75	**r: -0.02**		

Table 6*: Summary of descriptive statistics*

	Mean (M)	Standard Deviation (SD)	r	p-value
Null Hypothesis 1	83.94	13.19	-0.31	0.23
Null Hypothesis 2	44.11	31.06	-0.39	0.08
Null Hypothesis 3	85.63	9.59	-0.01	0.97
Null Hypothesis 4	81.27	21.14	0.35	0.29
Null Hypothesis 5	68.79	29.13	-0.02	0.89

Summary

The results from the Pearson product-moment correlation analyses indicate that the researcher should fail to reject all of the null hypotheses due to the fact that there is no statistically significant relationship between the number of college-level subject-specific content credit hours earned by teachers and the percentage of students scoring at the Meets or Exceeds level on the EOCTs.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, RECOMMENDATIONS

Introduction

Chapter five will restate the research problem and provide a review of the major methods used in this study. The purpose of this study was to determine if there was a relationship between the number of college subject-area content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests. The various sections of this chapter will summarize and discuss the results of this study.

Discussion

This study examined if teacher-earned subject-specific college content credit hours correlate with student scores on standardized achievement tests. It answered the following question:

> What is the relationship between subject-specific college content credit hours earned by high school teachers and student achievement on the four core academic subject area EOCTs?

As stated in prior chapters, this study focused on whether there was a relationship between subject-specific college content hours earned by high school teachers and student achievement on the EOCTs. Data collected from teachers was obtained via an electronic survey (Appendix D). Teacher ratings were then entered into an Excel spreadsheet. The percentage of students scoring at the meets or exceeds level on the EOCTs from the 2012-2013 school year were provided to the researcher in an Excel spreadsheet.

This quantitative study required the use of Pearson's Product Moment Correlation statistical test to determine the relationship between the number of subject-specific college content hours earned by teachers and students' EOCT scores. The Pearson's r statistical test was performed to determine if there was a statistically significant correlation between teachers' earned credit hours and the percentage of students scoring meets or exceeds on the EOCTs in each of the four core academic areas: 1) mathematics, 2) science, 3) social studies, and 4) English. A two-tailed p-value is presented in each table along with the critical r value necessary to reject the null hypothesis. A relationship was considered to be significant when the r obtained from the data equaled or exceeded the tabled critical r value at the .05 level of significant for the appropriate number of degrees of freedom. These statistical tests corresponded to the five null hypotheses of the study in regards to the four core academic areas, and all academic areas together.

Data analysis was performed separately on each of the four core academic subject areas (mathematics, science, social studies, English) and then all four subject areas together. The hypotheses were tested, and results indicated no statistically insignificant correlations. Mathematics correlations showed no overall relationship. Science showed no correlations between teacher content credit hours and student EOCT scores. Social studies showed no correlations. However, English showed a very weak positive correlation, though it was not strong enough to reject the associated null hypothesis. All four academic areas together also showed no correlations. After analyzing the correlations for this study, the results showed no overall correlation between teacher subject-specific content credit hours and student scores. The correlations did not result in rejection of the null hypotheses that stated that there is no relationship between the number of subject specific content credit hours completed by the teacher and the EOCT scores of students.

Null hypotheses 1-5 stated no correlation between high school teacher content credit hours and percentage of students scoring meets or exceeds on EOCTs as follows:

$H_0$1: There will be no correlation between the number of college-level science content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Biology EOCT and the Physical Science EOCT.

$H_0$2: There will be no correlation between the number of college-level mathematics content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia Coordinate Algebra EOCT and the Analytic Geometry EOCT.

$H_0$3: There will be no correlation between the number of college-level social studies content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia U.S. History EOCT and the Economics EOCT.

$H_0$4: There will be no correlation between the number of college-level English literature content credit hours earned by classroom teachers and the percentage of students scoring at the Meets or Exceeds level on the Georgia 9th Grade Literature EOCT and the American Literature EOCT.

$H_0$5: There will be no correlation between teacher subject-specific college degrees and the percentage of students scoring at the Meets or Exceeds level on the Georgia End of Course Tests.

Null hypothesis 1 had no significant correlation in regard to the percentage of students scoring meets or exceeds on the biology EOCT and physical science EOCT because $r = -0.31$. There was no significant correlation for the Coordinate Algebra EOCT and Analytic Geometry as r = -0.39, so null hypothesis 2 was not rejected. Null hypothesis 3 was also not rejected because no significant correlation was found in regard to U.S. History EOCT and Economics EOCT scores because r = -0.01. Null hypothesis 4 was also not rejected because of no significant correlation of r = 0.35 was found between student scores and English content credit hours earned by teachers. Finally, null hypothesis 5 was also not rejected because of the lack of a significant correlation (r = -0.02) being found with student scores for all four core academic areas and content credit hours earned by teachers in all subject areas.

This study revealed that the number of subject-specific content credit hours earned by teachers might play a very slight role in student achievement in English, even though it clearly is not the most important indicator of student achievement. The researcher could not find any study that examined the subject specific knowledge of high school teachers using college content hours. However, a study by Hill, Rowan, and Ball (2007) specifically compared elementary teachers' mathematical content knowledge with student achievement. The Hill, Rowan, and Ball (2007) study found that teachers' mathematical content knowledge was a significant predictor of student success in mathematics at the elementary level. Other studies by Baumert (2010) and Ojose (2012) also examined the role of mathematical content knowledge on student performance with opposing results. The Ojose (2012) study used a questionnaire to examine the content knowledge of algebra teachers. They found that teachers who possessed strong subject matter knowledge were able to use superior instructional strategies (real-life situations and alternative problem solving) more effectively than those teachers who had little or no content knowledge. In contrast, the Baumert (2010) study revealed that pedagogical content knowledge had a substantial positive effect on student gains on standardized tests. In 1994, Monk examined the effects of subject matter knowledge on the performance gains of secondary mathematics and science students. The results suggested that content knowledge has a positive effect on student achievement. Goldhaber & Brewer (2000) extended a previous study and found that unobservable characteristics in the school, classroom, and teachers accounted for more student achievement than content knowledge alone. The current study found that the number of subject-specific college content hours earned by high school teachers showed no correlation to student achievement overall. The conflicting results of the current and previous studies make it abundantly clear that much more research into teacher content knowledge needs to be conducted in order to determine best strategies for increasing student learning and achievement across the content areas. This study does add to the limited body of research about teacher subject-specific content knowledge as related to student achievement.

Conclusions

Overall, English did not produce any new evidence regarding the relationship between English content credit hours earned by teachers and student EOCT scores, so null hypothesis 4 was accepted. Science showed no relationship and therefore supported the science null hypothesis of the study. Mathematics yielded no relationship, so the mathematics null hypothesis was also supported in this study. Social studies also revealed no relationship, so null hypothesis 3 was also not rejected. Finally, when all teachers and scores were grouped together, no significant correlations were shown. Overall, all of the null hypotheses were unable to be rejected, which was slightly disappointing. The researcher hoped to find more significant, positive relationships between subject-specific content credit hours and student achievement on the EOCTs.

Limitations

The limitations of the current study are: 1) the target population was secondary public school teachers and their students; 2) the sample was a relatively small convenience sample composed of teachers and their students from two small rural public high schools in the same region of north Georgia; 3) the variables of interest were A) subject-specific college content courses taken by the teachers. The data for this variable was collected via an online self-reported questionnaire by the teacher. Content hours were recorded in ranges of 10 semester hours within specified content areas rather than whole integers. This was done to increase teacher response rates though it resulted in some sacrifice of accuracy; B) the other variable was the percentage of students scoring meets or exceeds on EOCTs and recorded by specific academic content areas (mathematics, social studies, science, and English). These scores were provided from the school records. 4) Research methodology and statistical analyses were approved by the researcher's doctoral dissertation committee.

The limitations of primary concern were the restriction on the correlation results due to the narrow population and small size of a sample of convenience, the self reporting of the teachers' number of semester credit hours which were reported by specified content areas and recorded as ranges rather than whole numbers. The anticipated effect of these limitations was to underestimate the actual relationship between the variables. The main concern in the field of education is that the cost of implementing new educational practices requires there to be an extremely high confidence that the proposed new practices will reliably and efficiently produce measurable improvement in student performance. The reason for the limitation of restricting the range of semester credit hours was related to the voluntary self-report aspect of data collection and was an attempt to increase the participation rates of the teachers.

Additional limitations include the fact that pre-existing EOCT scores from a previous school year were used in the study. Since archived scores were used, teachers from the previous school year were included in the study. Two of the teachers have moved into administrative positions and are no longer teaching in the classroom. Six of the teachers are no longer teaching in either of the two schools participating in the study. Also, the students taking the EOCTs were a mixture of on-level, gifted, special education, and ESOL students. Different correlation levels may have been obtained by examining the EOCT scores by student sub-groups.

Implications

The implications of the current study, while not supported by its findings, are supported in large part by the body of related research included in the literature review. Teachers who are very knowledgeable in the content area that they teach are more likely to produce higher achievement in their students than teachers who are less knowledgeable. Also, it is reasonable to expect that teachers who remain current in their content area will also have a positive impact on their students' academic performance. The results of this study also illustrate the fact that other knowledge (such as pedagogical knowledge or teacher efficacy) may play a role in effective teaching and learning in the classroom. The limitations of the current study may have prevented its results from providing additional support to the growing body of research, but it does suggest that continued pursuit of improving public secondary education in order to better prepare the next generation of leaders in America is needed. The results of the study could aid principals and superintendents with hiring and retaining highly qualified teachers. Because content knowledge is related, at least slightly, to student achievement scores overall, content knowledge should still be emphasized in college teacher education programs.

Additionally, the researcher could have obtained more precise data if one or both of the participating school systems employed a full-time data research employee. Instead of using a self-reporting survey, the researcher could have gone straight to the source and obtained a more accurate data set. However, due to a general lack of funding in public education, most school districts cannot afford to staff a full-time data research position. By employing such an individual, schools systems could more effectively use the data available for purposes such as tracking student progress, teacher retention rates, student attendance, and contributing to research studies.

Recommendations for Future Research

The limitations and implications of this study reveal both short-term and long-term recommendations. Subsequent studies on the present topic will need to heed the limitations of previous studies in order to overcome the weaknesses inherent in educational research and strengthen results that will positively impact student performance. The realities of the changing character of schools, teachers, and students will always be challenging obstacles to the quality of future educational research. The elements of education that are identified as "Best Practice" today are very likely to change in a relatively short period of time.

1. The current study involved a very small sample size. More studies involving additional schools, more diverse student populations, and a larger teacher sample size could produce results that are more statistically significant results.

2. Statistical analysis could be done to see if teacher content hours made a difference in student test scores separated by sub-groups.
3. Future studies could be tracked over the course of multiple years in order to determine whether teacher content knowledge changes over time.
4. Since this study shows that content expertise may not be a determining factor for student achievement, future research should examine the role of the teacher in the classroom and what other qualities might have greater effect on student achievement.
5. More research is needed on how colleges of education prepare future teachers and whether the content heavy focus of the courses is beneficial or whether the focus should be on teaching strategies, developing relationships with students, and creating a culture of high expectations for students.
6. The current study looked at the specific degree earned and whether or not it was in the content area in which the participant was teaching. Consideration was not given to the quality of the education the participants received, the size of the college or university they attended, whether it was public or private, or whether the college/university had data showing a high success rate for graduates.
7. This research project was conducted in order to meet a requirement of an institution of higher education as a way to demonstrate the development of academic skills necessary to make a contribution as a future educational leader. Resources, both financial and professional contacts, limit graduate students. Therefore, an important recommendation resulting from this valuable experience is that institutions of higher education and grade schools should forge cooperative collaborative partnerships to

order to acquire and share resources, and to address issues confronting education. Graduate student researchers could then become supervised interns working directly with school districts to reduce the limitations of most student research. Such partnerships would then refocus efforts from simply meeting the needs of advanced degree seeking students to addressing the more meaningful problems facing public education.

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Appendices

Appendix A: Demographic Information

Demographic information for participating high schools in north Georgia

school	Enrollment	Title I	AYP	Demographics						SWD	LEP	Free/reduced	Migrant
				Asian	Black	Hispanic	N.American	White	Multiracial				
High School 1	823	No	Met	3	3	7	0	87	0	15	1	61	0
High School 2	1130	no	did not meet	0	2	6	0	91	1	14	2	45	0

Appendix B: Superintendent permission form

Dear Superintendent,

I am currently a doctoral candidate in Curriculum and Instruction at Liberty University in Lynchburg, Virginia. The purpose and overall goal of my dissertation is to determine if there is a relationship between the number of subject-area content credit hours earned by classroom teachers and student achievement as measured by the Georgia End of Course Tests.

I propose to use the 2012-2013 EOCT mathematics, science, social studies, and English language arts scores of teachers in your school system. I, respectfully, request your permission to use the system data and contact the teachers in each of the high schools for a brief questionnaire concerning their demographics and educational history.

Upon your permission, my dissertation committee, and the Liberty University IRB, I will contact the principals to determine the approximate number of teachers to include in my research study. Your permission and support are crucial to this study and will be greatly appreciated. At your request, I will share the results with you and your school personnel at the conclusion of the research study.

Thank you for your consideration. If you have any questions, please feel free to contact me at XXX-XXX-XXXX; or by email at adevries2@liberty.edu.

Sincerely,

Ashleigh B. DeVries

Appendix C: Principal Consent Form

Dear Principal,

Your superintendent and the XXXX County School System have given permission for me to contact you. As part of the requirement to obtain my Doctor of Education degree at Liberty University in Lynchburg, Virginia, I am completing the dissertation component of degree program.

Your participation in this study is requested by submitting am email address of an assistant principal in charge of curriculum to serve as the contact person. Their responsibilities will be to: 1) provide the EOCT scores by teacher for the 2013-2013 school you; 2) forward a survey link to the EOCT teachers within your school.

Please verify the following contact's email address with your initials ________:

XXXX High School	XXXXXX@XXXXX.k12.ga.us

Sincerely,

Ashleigh B. DeVries

Purpose of Study:

The purpose of this study is to determine if there is a relationship between the number of subject-area content credit hours earned by high school classroom teachers and student achievement as measured by the Georgia End of Course Tests. Teacher demographic information will be gathered by an anonymous, electronic data collection tool.

Confidentiality Statement:

All records of this study will be kept secure and private. None of the information obtained from this study will be used in any publication or report so that a specific school or system is identified. Research records will be securely stored, and only the researcher will have access to the records *(i.e. System/school officials will not be able to obtain any individual responses).*

Voluntary Participation:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University, your school system, or the researcher.

Contacts and Questions:

The researcher conducting this study is Ashleigh B. DeVries. If at any time you have questions, you may contact us, or if you encounter problems regarding this study, you are encouraged to contact her at XXX-XXX-XXXX; or email at adevries2@liberty.edu. If you have any questions or concerns about your rights as a research participant and need to talk with someone other than the researcher, you may contact the Human Subject Office, 1971 University Blvd, Suite 2400, Lynchburg, VA 24502 or email fgarzon@liberty.edu.

Appendix D: EOCT Teacher Demographic Survey

1. What is your name?
2. How many years of classroom teaching experience do you have?
    a. Less than 5 years
    b. 5 to 10 years
    c. 10 to 15 years
    d. 15 to 20 years
    e. 20 to 25 years
    f. 25 to 30 years
    g. More than 30 years
3. What degree(s) do you currently hold?
4. Approximately how many college credit hours have year earned in your specific content area?
    a. Less than 10 credit hours
    b. 10-20 credit hours
    c. 20-30 credit hours
    d. More than 30 credit hours
5. Which EOCT course(s) did you teach during the 2012-2013 school year?

Appendix E: Summary of SEMS Across Administrations

SUMMARY OF SEMS ACROSS ADMINISTRATIONS

	Summer 2012	Winter 2012 Form 1/Form 2	Spring 2013 Form 1/Form 2
Ninth Grade Literature & Composition	3.65	3.35/3.35	3.30/3.31
American Literature & Composition	3.61	3.52/3.46	3.43/3.30
Biology	3.82	3.65/3.64	3.52/3.52
Physical Science	3.71	3.71/3.63	3.61/3.63
US History	3.68	3.49/3.54	3.43/3.39
Economics	3.61	3.53/3.50	3.52/3.44
Mathematics I	3.40	3.42/3.38	3.36/3.35
Mathematics II	3.34	3.30/3.28	3.35/3.34
Algebra	3.38	3.38/3.38	3.37/3.37
Geometry	3.35	3.30/3.30	3.28/3.26
Coordinate Algebra		3.28/NA	3.29/3.29

Appendix F: Consent Form

INFORMED CONSENT FORM FOR QUANTITATIVE RESEARCH STUDY

CONSENT FORM

Title of study: The Effect of Teacher Earned Subject-area Content Credit Hours on High School Student Achievement

Principal Investigator: Ashleigh Devries

Institute: Liberty University

Department: School of Education

You are invited to be in a research study of the effect of teacher earned subject-area content credit hours on high school student achievement as measured by the Georgia End Of Course Tests. You were selected as a possible participant because you teach an EOCT course. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Ashleigh DeVries, Liberty University School of Education.

Background Information:

The purpose of this study is to determine if there is a relationship between the number of subject-area content credit hours earned by classroom teachers and student achievement as measured by the Georgia End of Course Tests.

Procedures:

If you agree to be in this study, I would ask you to do the following things:

You will be asked to complete an online demographic survey with the following information: degree(s) held, years of teaching experience, subject(s) taught (biology, physical science, coordinate algebra, analytic geometry, U.S. history, economics, 9th grade literature, or American literature) and the total number of subject-area content college credit hours earned.

Once the survey is completed, the demographic information will be matched to your students' 2012-2013 EOCT scores.

Risks and Benefits of being in the Study:

No study is without risk, however, the risks associated with this study are no more than you would encounter in everyday life.

There is no direct benefit to you. However, the results of the study may help school administrators to hire and retain high quality teachers.

Compensation:

You will not receive any compensation for your participation in this study.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a participant. Research records will be stored securely and only the researcher will have access to the records. Your name and identity will also not be disclosed at any time. However, the data may be seen by an ethical review committee and may be published in an academic journal without disclosing your identity.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or your local school system. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Ashleigh Devries. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at adevries2@liberty.edu. You may also contact Dr. Scott Watson at swatson@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: ____ Date: ________________

Signature of Investigator:_______________________________ Date: __________________

IRB Code Numbers: 1942

Appendix G: Recruitment Email

Dear Teachers:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The purpose of my research is to determine if there is a relationship between the number of subject-area content credit hours earned by classroom teachers and student achievement as measured by the Georgia End of Course Tests, and I am writing to invite you to participate in my study.

You are being asked to participate in this study because you taught an EOCT course (Biology, Physical Science, Coordinate Algebra, Analytic Geometry, U.S. History, Economics, 9th Grade Literature, or American Literature) during the 2012-2013 school year. If you are willing to participate, you will be asked to complete short online demographic survey collecting information on college-level subject-area content hours earned, years of teaching experience, degree(s) held, and EOCT subject(s) taught. It should take approximately 5-10 minutes for you to complete the survey listed. Additionally, by agreeing to participate in this study, you authorize your school administrator (name will be changed depending on the school) to collect your EOCT scores. Your participation will be completely anonymous, and the researcher will view no personal or identifying information.

To participate, click on the survey link at the end of the consent information to indicate that you have read the consent information and would like to take part in the survey.

A consent document is attached to this letter. The consent document contains additional information about my research. Please sign the consent document and return it to your school administrator.

Sincerely,

Ashleigh DeVries

Liberty University Doctoral Candidate

APPENDIX H: IRB APPROVAL

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

September 5, 2014

Ashleigh DeVries
IRB Exemption 1942.090514: The Effect of Teacher-Earned, Subject-Area Content Credit Hours on High School Student Achievement

Dear Ashleigh,

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

Your study falls under exemption category 46.101 (b)(2, 4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:

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

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

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

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