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Stem Career Cluster Engineering and Technology Education Pathway in Georgia: Perceptions of Georgia Engineering and Technology Education High School Teachers and CTAE Administrators as Measured by the Characteristics of Engineering and Technology Education Survey

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STEM CAREER CLUSTER ENGINEERING AND TECHNOLOGY EDUCATION PATHWAY IN GEORGIA: PERCEPTIONS OF GEORGIA ENGINEERING AND TECHNOLOGY EDUCATION HIGH SCHOOL TEACHERS AND CTAE ADMINISTRATORS AS MEASURED BY THE CHARACTERISTICS OF ENGINEERING AND TECHNOLOGY EDUCATION SURVEY

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by
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ABSTRACT

This study examined the perceptions held by Georgia Science, Technology, Engineering, and Mathematics (STEM) Career Cluster Engineering and Technology Education (ETE) high school pathway teachers and Georgia's Career, Technical and Agriculture Education (CTAE) administrators regarding the ETE pathway and its effect on implementation within their district and schools. It provides strategies for ETE teaching methods, curriculum content, STEM integration, and how to improve the ETE pathway program of study. Current teaching and curricular trends were examined in ETE as well as the role ETE should play as related to STEM education. The study, using the Characteristics of Engineering and Technology Education Survey, was conducted to answer the following research questions: (a) Is there a significant difference in the perception of ETE teaching methodology between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey? (b) Is there a significant difference in the perception of ETE curriculum content between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey? (c) Is there a significant difference in the perception of STEM integration in the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey? and (d) Is there a significant difference in the perception of how to improve the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as

measured by the Characteristics of Engineering and Technology Education Survey?

Suggestions for further research also were offered.

DEDICATION

This dissertation is dedicated to my wife, Sharon, and parents, Dennis and Judy Crenshaw. Your faith and love along with your belief in my abilities to accomplish what I strive for in life has been unfailing. Thank you for your support in all that I have done throughout my career.

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CHAPTER ONE

INTRODUCTION

Career and technical education (CTE), or career, technical and agricultural education (CTAE) as it is currently known in Georgia, was formally vocational/industrial arts education, is the primary system through which youth and adults are prepared to enter competitive employment and/or continue with lifelong learning (Scott & Sarkees-Wirenski, 2001). Major changes in CTE have happened since its inception in the late 1880s. The continuation of CTE in the U.S. educational system has been recognized and value has been placed on the need to prepare people for the workplace. With the passage of the Smith-Hughes Act of 1917, the federal government recognized the need to promote vocational education and began providing federal funds for vocational training. Funding for vocational education continued with the passage of the Carl D. Perkins Vocational and Applied Technology Education Act of 1984 and subsequent reauthorizations in 1990, 1998, and 2006. The purpose of the Perkins Act was to make the United States more competitive in the world economy by developing more fully the academic and occupational skills of all segments of the population. The most recent active federal funding provided for career and technical education is the Carl D. Perkins Career and Technical Education Improvement Act of 2006. This legislation continues to emphasize academic achievement and preparing young people to become both college and career ready. The general attitude is that schools must provide extensive learning opportunities to better serve the needs of youth and society (Giachino & Gallington, 1967). Schools today have the responsibility of educating students to become productive members not only of society but also of the workplace.

CTE emphasizes a broader preparation for students that includes developing academic, occupational, and technical skills. In the development of these skills the integration of academic and technical content is emphasized within all aspects of business and industry. CTE programs are placing greater emphasis on critical thinking, personal responsibility, social skills, and leadership/followership skills to better prepare their students for modern workplace realities (Scott & Sarkees-Wirenski, 2001). A wide variety of instructional delivery systems are being used in secondary schools to accomplish this. Students are learning concepts and theories in a wide spectrum of topics from specific technical job-related content to career awareness in CTE programs but are doing so in an array of instructional strategies that include general classroom instruction, laboratory applications, supervised work experiences, and career and technical student organizations.

Lynch (2000) reported that one or more CTE courses are offered in 93% of the nation's 15,200 comprehensive high schools and about 75% of all comprehensive high schools offer specialized labor market preparation programs for CTE concentrators. *Concentrators* are defined as students who take three or more sequenced CTE courses in one program area (Lynch, 2000). ACTE (2014) reported that in 2002, 88 percent of public high schools offered at least one CTE program. In addition, many high schools are served by area career centers—1,200 in 41 states, as of 2002. In the 2010-2011 school year, according to the Office of Career, Technical and Adult Education, there were

7,494,042 secondary CTE participants, or students who took at least 1 credit of CTE, and 3,020,163 CTE concentrators who took multiple CTE credits in one career pathway (ACTE, 2014). This growth indicates that a career focused approach, CTE, to making high school matter is working.

In 2000, the International Technology Education Association (ITEA) now referred to as the International Technology and Engineering Educators Association (ITEEA) since 2010, through its Technology for all Americans Project, released the Standards for Technological Literacy: Content for the Study of Technology (STL). The STL provide an important foundational basis for the study of technology in terms of content. Critical to the successful implementation of technology education programs in the comprehensive high schools is the support of the school principal (Raizen, Sellwood, Todd, & Vickers, 1995). For this to be accomplished, administrators must have a clear understanding of the critical role technology education can play in the general curriculum and must communicate the value of technology through the priority and resources they give it (Raizen et al., 1995). However, due to significant changes in CTE, principals' perceptions and attitudes may vary and may or may not reflect current curriculum and instructional practices. The state of Georgia spent millions of dollars building and equipping new and renovated technology education classrooms and laboratories since the late 1980s (Hill, 1997). Along with new and renovated labs, contemporary instructional strategies have been implemented over the years to match current trends in the field to technology education (Hill, 1997). Though updated laboratories and instructional strategies are necessary for quality engineering and technology education (ETE) programs, students benefit most from positive perceptions, attitudes, knowledge, and understanding concerning ETE by building and district CTAE administrators and their ETE teachers. This study focused only on Georgia Science, Technology, Engineering, and Mathematics (STEM) Career Cluster ETE high school teachers' and CTAE administrators' perceptions toward CTE, in particular the ETE high school pathway.

Statement of the Problem

Little information is available to CTAE leaders in Georgia regarding the perceptions of STEM Career Cluster ETE high school teachers and CTAE administrators toward CTAE programs. The purpose of this study was to investigate and compare the perceptions affiliated with the STEM Career Cluster ETE high school pathway as perceived by Georgia STEM Career Cluster ETE high school teachers and associated CTAE administrators and to determine whether differences exist between the two major stakeholder groups and its effect on implementation within their district and schools.

Purpose of the Study

The purpose of this study was to determine whether Georgia STEM Career Cluster ETE high school teachers and CTAE administrators agree about selected characteristics regarding the STEM ETE high school pathway. Had differences been found by utilizing Daugherty and Wicklein' s (Daugherty, 1991) modified Characteristics of Technology Education Survey (CTES), now referred to as the Characteristics of Engineering and Technology Education Survey (CETES), further analysis was planned to identify the nature of the disagreement. Second, this study may provide data for

Georgia's local-level administrators, teacher educators, and teachers regarding administrators' and teachers' views of CTE programs, in particular the STEM ETE pathway in their local school districts and how these views may affect its successful implementation. The data may also be used by the University System of Georgia and the Technical College System of Georgia to aid in the establishment/re-establishment of an undergraduate/graduate STEM ETE teacher certification preparation program.

Significance of the Study

The researcher believes that since no recent attitudinal or status study has been conducted among Georgia STEM Career Cluster ETE high school teachers and CTAE administrators concerning the ETE high school pathway, the information acquired will help state and local CTAE administrators in planning and promoting the program for the future.

The study is important in that, since the local CTAE administrator plays an important part in influencing the attitudes of local administrators, faculty members, and students as well as the community, this influence will be particularly important with regard to the recruitment of students, parents, and the community for support of CTAE programs, especially the ETE pathway, in their local high schools. Best put by Bottoms (1983) when he wrote,

> For a long time it has been apparent to this researcher that comprehensive high schools with quality programs of vocational education (now referred to as career and technical education) have not only outstanding building level administrators who have a commitment to CTAE education, but are supported by the local

> CTAE administrators. Those CTAE administrators foster an overall climate of enthusiasm for CTAE, providing proper recognition to CTAE education staff and curriculum within the structure of the district and school. (p. 21)

Because CTAE administrators are the leaders of the CTAE programs in their districts and schools and have considerable power in making decisions concerning the selection and implementation within the schools, it is crucial to obtain their perceptions and attitudes. The study allowed the researcher to identify which of the four areas (teaching methodology, curriculum content, STEM integration, and how to improve engineering and technology) have been perceived differently by the main stakeholders as it relates to Georgia's STEM Career Cluster ETE high school pathway. This information is critical in the planning, implementing, and evaluation of technical ETE programs in Georgia to ensure the future success of CTAE for students.

Research Questions

The following research questions were used to guide this descriptive research investigation:

1. Is there a significant difference in the perception of ETE teaching methodology between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
2. Is there a significant difference in the perception of ETE curriculum content between Georgia ETE high school teachers and CTAE administrators as

measured by the Characteristics of Engineering and Technology Education Survey?

3. Is there a significant difference in the perception of STEM integration in the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
4. Is there a significant difference in the perception of how to improve the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?

Null Hypotheses

The research questions furnished the basis for the testing of the following four null hypotheses:

H_o1: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey (CETES) regarding ETE teaching methodology.

H_o2: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES regarding ETE curriculum content.

H_o3: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES regarding the integration of STEM in the ETE high school pathway.

H_o4: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES regarding how to improve the ETE high school pathway.

Assumptions of the Study

Basic assumptions that underlie the statement of the problem are as follows:

1. Georgia CTAE administrators are willing to share their perceptions and attitudes by responding in a professional and conscientious manner.
2. Georgia STEM Career Cluster ETE high school teachers are willing to share their perceptions and attitudes by responding in a professional and conscientious manner.
3. Georgia CTAE administrators and ETE teachers have positive perceptions and attitudes of the many aspects of CTAE.
4. Georgia CTAE administrators provide the major influence in selecting CTAE programs, developing curriculum goals, maintaining quality instruction, and offering relevant CTAE education programs to qualified students.
5. Perceptions and attitudes are measurable through a survey instrument.
6. Respondents selected to be surveyed responded to the questionnaire in an honest and candid manner.

Limitations of the Study

The development of the study reflects certain limitations.

1. The study is confined to local school districts in Georgia.
2. The study is limited to the degree of cooperation of Georgia CTAE administrators who responded to the questionnaire objectively.
3. The study is limited to the degree of cooperation of Georgia STEM Career Cluster ETE high school teachers who responded to the questionnaire objectively.

Scope of the Study

The scope of the study was limited to high school ETE pathway teachers and district CTAE administrators in Georgia. The methods employed in this study can be adapted to administrators in other states who want to gather data about their ETE programs to determine what needs to be developed or improved.

Definition of Terms

1. Administrators refer to those individuals who manage any aspect of the educational system, including directors, supervisors, principals, assistant principals, or teachers as appropriate.
2. Attitude is defined as a mental or neural state of readiness, which is organized through experience and exerts a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. Attitudes are effective, behavioral, and cognitive (Rajecki, 1982).

3. Career and Technical Education (CTE) is defined as educational programs that serve the purpose of providing learning experiences that help students explore career areas and prepare for employment and independence. These programs make use of real-life situations in classrooms and laboratories as well as supervised work experiences (Scott & Sarkees-Wirenski, 2001).
4. Career Cluster is defined as a grouping of occupations according to common knowledge and skills for the purpose of organizing educational programs and curricula (Hull, 2005).
5. Career, Technical, and Agricultural Education/Vocational (CTAE/Vocational) Administrator is defined as the administrator employed in any school system that is in charge of administering the CTAE/vocational program.
6. College and Career Academy, as defined in Senate Bill 161 (OCGA 20-4-37), signed by Governor Nathan Deal on May 11, 2011, is a

    > Specialized charter school established by a partnership which demonstrates a collaboration between business, industry, and community stakeholders to advance workforce development between one or more local boards of education, a private individual, a private organization, or a state or local public entity in cooperation with one or more postsecondary institutions.

7. Comprehensive High School is defined as a high school setting that has diversified programs in sufficient number to meet the needs and preferences

of the student body (Wenrich & Wenrich, 1974). This term is used interchangeably with *secondary school*.

8. Educators are defined as those professionals involved in the teaching and learning process, including teachers and administrators.
9. High School is defined as a school consisting of Grades 9–12.
10. Industrial Arts is defined as an area of general education involving experiences with a wide range of industrial materials, tools, processes, products, and occupations typical of an industrial society.
11. Pathway is a coherent, articulated sequence of rigorous academic and career/technical courses, commencing in the ninth grade and leading to an associate's degree, baccalaureate degree, and beyond; an industry-recognized certificate; and/or licensure (Hull, 2005).
12. Perception is defined as an understanding, belief, or attitude.
13. Principal is defined as the administrative head of the school.
14. STEM: science, technology, engineering, and math.
15. Technological Literacy is defined as the ability to use, manage, assess, and understand technology (International Technology Education Association, 2000)
16. Technology is defined as the application of ingenuity and resources to extend human capabilities (International Technology Education Association [ITEA], 1996).

17. Technology Education (formerly known as industrial arts/vocational education) is defined as a CTE program that focuses on the study of technology as a means of developing technological literacy (Scott & Sarkees-Wirenski, 2001).
18. Vocational Education is defined as public school instruction that develops the basic skill, judgment, and job knowledge sufficient to prepare one for entry-level employment in agriculture, business, distribution, homemaking, industrial, and other occupational areas.

Organization of the Study

The study investigated the perceptions held by Georgia STEM Career Cluster ETE high school teachers and CTAE administrators regarding the ETE high school pathway. The study is organized into five chapters.

Chapter 1 presented an introduction, statement of a problem, purpose of the study, significance of the study, research questions used to guide the study, null hypotheses, assumptions of the study, limitations of the study, and definition of terms.

Chapter 2 contains an extensive review of the research and related literature.

Chapter 3 describes the methodology and research design used in conducting the study.

Chapter 4 presents the analysis of the data obtained in the study.

Chapter 5 presents a summary of the study, conclusions, and recommendations for further study.

CHAPTER TWO
REVIEW OF RESEARCH AND RELATED LITERATURE

Introduction

The review of research and related literature for this study focused on three areas: CTE, ETE education, and STEM education.

Career and Technical Education

Scott, (Scott & Sarkees-Wirenski, 2001) in his text, defined Career and Technical Education as a tremendous number of programs designed to give students the skills necessary for work and life. Career and Technical Education (CTE) today provides cutting-edge, rigorous and relevant instruction preparing youth and adults for a wide range of high-wage, high-skill, high-demand careers (ACTE, 2014). Nationwide, CTE programs are changing, evolving, and innovating to better serve the country's needs (National Association of State Directors of Career Technical Education Consortium [NASDCTEc], 2014). CTE has been in a constant state of change since its early inception so that students who wish to continue their education beyond the secondary level may do so or will be prepared to enter the competitive workplace, in today's lexicon this is phrased as being, "college and career ready".

Unlike in other countries where the trades, craftsmanship, and apprenticeships have had a unifying presence in the development of CTE, in the United States, the development has often been the result of competing interests of federal, state, and local policies (Hayward & Benson, 1993). The overall purpose of education is to ensure that the United States has a skilled work force and engaged citizenry to keep the nation, economy, communities, and families healthy and productive (Brand, 2008). From workforce development to student achievement, CTE is fulfilling the overall purpose of education in the United States. CTE provides students of all ages with the academic and technical skills, knowledge, and training necessary to succeed in future careers and to become lifelong learners (National Association of State Directors of Career Technical Education Consortium [NASDCTEc], 2014).

Schools were largely held to the elements of a liberal education during the first decade of the 20th century (Miller, 1985; Snedden, 1910; Wonacott, 2003). This liberal education was designed to serve those students going to college and was not concerned with instilling work-related characteristics (Wonacott, 2003). Snedden (1910) characterized this liberal education as one concerned with consuming and not with making efficient producers. The establishment of vocational education as an alternative for those who were leaving school at an early age would vastly extend general education as well as provide a reason for continued school attendance, and democratize education (Miller, 1985). Miller (1985) also believed there were several other added benefits to vocational education, such as making education more meaningful and increasing the wage-earning capacity of both girls and boys. The hands-on nature of vocational education made education purposeful and useful for the student's role in life. Likewise, Snedden (1910) drew a clear distinction between vocational education and liberal education. According to Wonacott (2003), Snedden believed that liberal education involved the broadening of the individual's mind and emotional horizons; whereas vocational education was aimed toward training of efficient producers or those with the capacity to earn a living and contribute to productive work (Baldwin, 2011).

The passage of the Smith-Hughes Act of 1917 demonstrated the first federal support for vocational education (Gordon, Yocke, Maldonado, & Saddler, 2007; Hayward & Benson, 1993; Lynch, 2000). The Smith Hughes Act is considered the cornerstone of CTE legislation. As an alternative to the general curriculum found in schools at the time, the Smith Hughes Act of 1917 was enacted to prepare youth for jobs resulting from the industrial revolution (Lynch, 2000). It was confirming legislation that assured Americans that vocational education was a priority. The Smith-Hughes Act of 1917 established vocational education as a separate and distinct system of education (Gordon et al., 2007). The Act established a governing board, provided categorical funding, provided for teachers' salaries and training, and required states to develop a plan for vocational education and also to make annual reports on its progress. Additionally, beginning with the Smith-Hughes Act of 1917, the Federal Government became more involved in secondary education by increasing access to "vocational education," for the purpose of addressing the lack of skilled workers in agriculture and manufacturing, and preparing the workforce for the increasing industrialization of the economy (Center for Occupational Research and Development [CORD], 2012).

Moreover, the passage of the Smith-Hughes Act mandated segregation of academic and vocational students and curriculum (Baldwin, 2011). This led to programs being established within vocational programs, which led to further segregation by subject matter (Hayward & Benson, 1993). These programs were not only distinguished from the academic programs but also were implemented in ways to distinguish one vocational program from another. The impact of this separation continues today with the advent of separate teacher training programs in the university systems, separate teacher organizations, and separate student organizations (Baldwin, 2011).

The Smith-Hughes Act of 1917 emphasized job-specific skills to the exclusion of the traditional curriculum (Gordon et al., 2007). The focus of federal legislation shifted over the years to offer more programs and training for boys and girls to support national defense efforts in the 1920s, to reduce unemployment problems in the 1930s, to assist the war effort in the 1940s, to include junior colleges in the 1950s, and to promote peacetime economic development in the 1950s and 1960s (Lynch, 2000). Ironically, the concerns that led to the Smith Hughes Act of 1917 and the legislation that followed are still being discussed today by secondary school systems, the technical college systems, and university system leaders, as many business and industries still express concern that there is a lack of trained workers entering the workforce today.

The Vocational Education Act of 1963 (Public Law [Pub. L.] 88-210) brought about major changes in vocational education. The central theme was to broaden the concepts of education for work and training, and to better meet the needs of different groups of people. The federal government sought to expand influence over the state vocational education programs (Hayward & Benson, 1993). A significant shift in federal policy regarding CTE began to take shape. This move from an exclusive focus on job preparation for a trained work force to a shared purpose of meeting the economic demands also included a social component (Rojewski, 2002). An emphasis on teaching employability skills and human resource needs to underserved populations and displaced workers created this major shift in the country's thinking about vocational-technical education. In addition, later amendments to the Vocational Education Act of 1963 in 1968 and 1972 continued to authorize federal grants to states, maintain, expand and improve existing vocational-technical education programs.

The Carl D. Perkins Act has been instrumental in the creation of our modern day career and technical education programs of study. Congressman Perkins, from Kentucky's 7th district, believed that the Vocational Education Act of 1963 was inadequate. Named after the former chair of the House Subcommittee on Vocational Education, Congress passed the Carl D. Perkins Vocational and Applied Technology Act in 1984 (Pub. L. 98-524). The Perkins Act contained two main goals: (a) the improvement of vocational-technical programs and (b) better services and increased access to vocational education for students with special needs (Lynch, 2000). The first goal was directed toward raising the productivity of the work force. The second goal was to increase access for individuals who were disadvantaged, handicapped, those entering nontraditional occupations for their sex, adults in need of training or retraining, single parents or homemakers, individuals with limited English proficiency, and individuals who were incarcerated (Baldwin, 2011). Both goals were ambiguous as vocational programs played a very small role in the productivity of the work force and special needs populations were ill equipped to meet the academic rigors of entering vocational programs (Hayward & Benson, 1993). The Perkins Act changed the focus of career and technical education to focus more on the teaching of employability skills.

Moving forward, in 1990, the legislature passed the Carl D. Perkins Vocational and Applied Technology Act of 1990 (Perkins II; Pub. L. 101-392). This legislation represented the most significant policy shift in the history of federal involvement in vocational-technical education funding (Hayward & Benson, 1993). For the first time in federal vocational education legislation, emphasis was placed on academics and funds could be directed to all segments of the population (Lynch, 2000). The emphasis placed on serving special needs students was tempered somewhat by the high level of publicity and effort devoted to increasing academic standards in CTE programs (Rojewski, 2002). This legislation was grounded in school reform, and the mandate was to use federal funds to improve students' performance and achievement (Wonacott, 2003). Perkins II called for programs to develop more fully the academic and occupational skills of all segments of the population (Lynch, 2000; Wonacott, 2003). The Act assisted states and local schools in teaching the skills and competencies necessary for students to acquire work in a technologically advanced society.

Further, the Perkins Act saw rise to the technical preparation (Tech-Prep) program. Congress's intent in funding tech prep was to provide planning and demonstration grants to a consortia of local education agencies and postsecondary educational institutions to develop and operate coordinated programs (Baldwin, 2011). These programs were to require academic skills, technical skills, and articulation agreements designed to lead to an associate's degree or certificate in a specific career field (Lynch, 2000). As a result, Congress set the stage for a three-pronged approach to better prepare a highly skilled work force with the passage of Perkins II. According to

Hayward and Benson (1993), Perkins II emphasized “[a] the integration of academic and vocational education, [b] articulation between segments of education engaged, in work force preparation—epitomized by Congressional support of Tech Prep, and [c] closer linkages between school and work” (p. 17). In addition, the 1990 revision of the Carl D. Perkins Act placed emphasis on grants for facilities and equipment, career guidance and counseling, community based organizations that would serve the disadvantaged and bilingual programs.

The next piece of legislation that has had a great impact on CTE was the passage of the Carl D. Perkins Vocational and Applied Technology Amendments of 1998 (Pub. L. 105-332; Perkins III). The development of academic, vocational, and technical skills of students through high standards and linking secondary and postsecondary programs was the primary focus of the new Perkins amendment (Lynch, 2000; Wonacott, 2003). If CTE programs are to thrive, CTE partnerships must collect data that proves the value of their programs to policymakers at the federal level (Hull, 2005). To prove the worth of their programs the 1998 revision of the Carl D. Perkins Act required that states provide data on four core indicators of performance: student attainment of identified academic and vocational proficiencies; attainment of a high school diploma or postsecondary credential; placement in postsecondary education, the military, or employment; and student participation in and completion of nontraditional training and employment programs (Gordon et al., 2007). In CTE there are several additional indicators of success that are measured such as technical skills attainment, enrollments in advanced skill courses, receipt of certificates and credentials, job placement in chosen careers, and earning levels (Hull, 2005).

In February 2003, months before its scheduled expiration, the George W. Bush administration released its initial blueprint for the reauthorization of the Perkins Act of 1998 (Brustein, 2006). This initial request made significant changes to the program with a drastic cut in funding. The complete overhaul would have included the possible transfer of Perkins funds to No Child Left Behind Act (NCLB) activities, competitive funding, and a shift away from the focus on career and technical skill achievement (Brustein, 2006). After much deliberation and debate between the House and Senate, the Carl D. Perkins Career and Technical Education Improvement Act of 2006 (Pub. L. 109-270) was signed into law. The passage of this legislation showed that Congress overwhelmingly supported CTE (Brustein, 2006).

The current federal legislation under which CTE operates is the Carl D. Perkins Career and Technical Education Improvement Act of 2006 as it was authorized through the year 2012. The bulk of the law is similar to the 1998 legislation; however, there are some significant changes in content and focus (Association for Career and Technical Education [ACTE], 2006). One of the most significant changes in the law is the use of the term *career technical education* instead of *vocational education*. Within the legislation, several themes are present, including accountability for results and program improvement at all levels, increased coordination within the CTE system, stronger academic and technical integration, connections between secondary and postsecondary education, and links to business and industry (ACTE, 2006). Accordingly, core performance indicators for placement rates of CTE concentrators and nontraditional participation and placement also are present in the 2006 legislation (Brustein, 2006). Additionally, an emphasis on high-demand occupations and those that are high-skill and high-wage is also the focus. References also are made to entrepreneurship, small business, and the involvement of workforce investment boards within CTE programs (Baldwin, 2011). These linkages emphasize the role that employment availability and local economies should play in CTE programs (Brustein, 2006). Regarding federal legislation and funding of CTE, Lynch (2000) summed it up as follows:

> It seems increasingly clear that we have almost come full circle with federal direction of vocational education. The post-turn-of-the-century legislation was enacted to prepare students with the type of education it was thought they would need to run farms and factories of the 20th century. Today, Perkins III challenges us to prepare more students with the contemporary education they will need to work successfully in the ever-changing, technologically sophisticated, and internationally competitive workplaces (p. 10) (Baldwin, 2011).

One approach to preparing students with the contemporary education they will need for both college and careers aligning academic and technical content and secondary and postsecondary instruction was "career clusters" within which there are "career pathways" (Stone & Lewis, 2012). The career clusters initiative was first defined in 1998 through the U.S. Department of Education Office of Vocational and Adult Education and later launched in June 2001, 16 career clusters were identified representing career opportunities for the economy of the 21st century (Baldwin, 2011). However, in 2002, the career clusters initiative was taken over by the NASDCTEc (Ruffing, 2006). These career clusters frame students' opportunities as they pursue postsecondary education and a wide range of career opportunities. Helping students achieve their dreams by facilitating the education component of workforce development was the driving force behind this initiative (Losh, 2002). Further, the career clusters initiative, through a broad-based advisory committee, was charged to establish curriculum frameworks and supportive materials for each cluster area (Baldwin, 2011). The national advisory committee consisted of members from each of the 16 cluster areas. The national and state advisory committees were responsible for identifying the frameworks, pathways, foundation knowledge and skills, and other supportive materials (Losh, 2002). These committees included representatives from states, schools, education and training, business and industry, associations, and others directly impacted by the materials (Baldwin, 2011).

According to Baldwin (2011) the vision for CTE has become more career focused with the intent to combine rigorous academics, employability skills, and occupational knowledge and skill sets within career clusters. Focusing on program curricula rather than specific technical areas, the sixteen national career clusters have provided a broader career readiness focus. These broad curricula areas organize both academic and occupational knowledge and skill sets into coherent pathways that address various related occupational areas (Ruffing, 2006). Traditional vocational education meant preparing students for specific jobs. While this was sufficient for the economy of the 20th century, the new market place, the influence and rapidity of advances in technology, and the globalization of business and industry have signaled significant workplace changes and trends that make this traditional preparation insufficient (Hull, 2005). Career clusters represent a significant departure from conventional vocational education in that they promote (and demand) academic rigor and give students versatile skills that equip them for ranges of related occupations, rather than for narrow, task-specific jobs (Hull, 2005). Within each of the clusters, there are career pathways that specify the skills and knowledge to be acquired to enter occupations at various levels within the cluster (Stone & Lewis, 2012).

The state of Georgia has transitioned to 16 career clusters in the National Career Clusters Framework. Moreover, Georgia developed an energy career cluster in 2013 in addition to the original 16 Career Clusters based on state work force and industry needs. Georgia is currently implementing pathways of study associated with the following 17 Career Clusters:

- Agriculture, Food & Natural Resources Career Clusters
- Architecture & Construction Career Clusters
- Arts, A/V [audiovisual] Technology & Communications Career Clusters
- Business Management & Administration Career Clusters
- Education & Training Career Clusters
- Energy Career Clusters
- Finance Career Clusters
- Government & Public Administration Career Clusters
- Health Science Career Clusters

- Hospitality & Tourism Career Clusters
- Human Services Career Clusters
- Information Technology Career Clusters
- Law, Public Safety, Corrections & Security Career Clusters
- Manufacturing Career Clusters
- Marketing Career Clusters
- Science, Technology, Engineering & Mathematics Career Clusters
- Transportation, Distribution & Logistics Career Clusters (Georgia Department of Education, 2014)

The STEM Career Cluster, as defined by the NASDCTEc (2014), is the planning, managing, and providing of scientific research and professional and technical services (e.g., physical science, social science, and engineering), including laboratory and testing services and research and development services. Within the STEM Career Cluster in Georgia are the following programs of study, or pathways: Engineering and Technology, Engineering Drafting and Design, and Electronics.

A career pathway is a coherent, articulated sequence of rigorous academic and career/technical courses, commencing in the ninth grade and leading to an associate's degree, baccalaureate degree, and beyond; an industry-recognized certificate; and/or licensure (Hull, 2005). In Georgia, House Bill 186, signed into law by Governor Nathan Deal in 2011, specifically addressed college and career readiness. This bill expanded career pathway options for high school students to ensure their college and career readiness upon graduation, but also mandated that beginning in the 2013 school year, all ninth-grade students will determine a career path and take classes, both academic and within a career cluster, tailored to that goal.

High-quality CTE courses offered as part of career pathways that lead to a variety of occupations can increase student engagement, improve their academic achievement, and ease their transition to further education or employment (Stone & Lewis, 2012). CTE courses, their content and pedagogy, bring rigor, relevance, and relationships to the educational processes of students, providing the opportunity for understanding as to why they are having to learn what they are learning and how it will open opportunities for success. The STEM Career Cluster ETE high school pathway provides such courses in Georgia.

Engineering and Technology Education

Over the years, literature suggests differences in definitions, purposes, objectives, philosophies, curricula, and teaching methodologies as related to ETE. The role and purpose of ETE and its predecessors have been debated in public education for more than a half century by engineering and technology education professionals (Akmal, Oaks, & Barker, 2002; Erekson & Shumway, 2006; Sanders, 2001). ETE has gone through considerable changes since its inception in the early 1980s. Alternatively, a question could be posed: Has the field of ETE gone through considerable changes since its inception in the educational system since the early 1800s? Clarifying the confusion further, another question must be posed: What do the words *vocational/industrial arts* mean in the U.S. educational vocabulary? It is now evident that there is great confusion between ETE and vocational/industrial arts education as it pertains to the general education in schools. To this day, these philosophical and perceptional problems within the profession exist and are widely debated and publicized.

Before ETE, a dominant program existed for many decades called vocational/industrial arts. Vocational/industrial arts have been defined in many different ways by many different people and organizations. In 1931, Frederick Gordon Bonser and Lois Coffey Mossman, two college educators, had the greatest influence in the industrial arts educational movement that is now known as technology education. The two men, during an philosophical shift in vocational educational to career exploration, were best known for bringing industrial arts to elementary schools with their book, *Industrial Arts for Elementary Schools.* In their book, they defined *industrial arts* as education about "the changes in to the forms of materials made by man to increase their values, and of the problems of life related to those changes" (as cited in P. N. Foster, 1994, p. 17). Another definition is "those phases of general education which deal with industry—its organization, materials, occupations, processes, and products—and with the problems of life resulting from the industrial and technological nature of society" (Wilbur, 1954, p. 2). For the purpose of this study, *industrial arts* is defined as those phases of general education that deal with industry, its organization, materials, occupations, processes, and products, and with the problems resulting from the industrial and technological nature of society (Wilbur, 1954). However, the term *industrial arts* did not become official in the general education track until the 1900s.

As stated previously, industrial arts still has a presence in schools today. Hence, vocational/industrial arts teach students the basic processes as well as specifics, for example, the processes of woodworking, metalworking, and graphic arts. The curriculum for vocational/industrial arts classes was self-contained, meaning there was little to no formal integration with other academic disciplines. It was in 1905 that then-Governor of Massachusetts William L. Douglas appointed a special commission whose mission was to investigate the current education situation in his state (Boe, 2010). In response, the Douglas Commission cited a need for a focus on vocational/industrial arts education in the K–12 system. It was soon after that the signing of the Smith-Hughes Act of 1917 took place.

The Smith-Hughes Act of 1917 established funding for vocational/industrial arts educational programs in public schools through the federal government, thus the beginning of a new era in vocational/industrial arts education in the United States. It was this Act that caused a major division based on philosophical differences among teaching professionals (P. N. Foster, 1995). Some believed that industrial arts education should be taught in separate schools with a separate curriculum (the beginning of vocational/career centers). However, there were those who believed industrial arts were just as important as the three R's (reading, writing, and arithmetic) and should be equally represented in the traditional school setting. Sanders (2001) reinforced this debate by stating that even though the Smith-Hughes Act of 1917 helped validate vocational/industrial arts education, it also created a split along philosophical lines: One group believed in continuing the development of trade and industrial education, whereas the other integrated general education ideals into their curriculum.

Vocational/industrial arts was, and still is, considered a shop-work subject in the general education track, and its purpose is to develop a strong foundation in the skills, knowledge, and attitudes that are related to many aspects of American industrialization. Students were, and still are in some cases, provided the opportunity to explore the various aspects of industry that assist in their choice of a particular vocation. The vocational/industrial arts curriculum was designed to meet the needs of students so that they would be able to accomplish the many activities and experiences related to industry problems and processes. The objective was that students would develop an interest and appreciation for industrial life and processes. Ultimately, the purpose was to prepare each student for employment in the industrial work force. The vocational/industrial arts curriculum was designed with little to no formal integration of other general education disciplines such as science, math, and language arts. If these disciplines were integrated, the student would be able to understand not only the process but also the theories and reasoning behind it. However, unlike the ETE curriculum of today, in many people's minds, a vocational/industrial art was a shop class in which students were learning how to hammer and nail. During this time, however, many varying vocational/industrial arts curriculum projects were attempted. Two in particular, created by Dr. Donald Lux and Dr. Willis Ray of Ohio State University, were from the Industrial Arts Curriculum Project (Rogers, 2005). The intent was that upon development, these curricula would be accepted and taught across the nation just like any typical math, science, and language arts curriculum. The two curricula programs were titled The World of Construction and The World of Manufacturing.

The World of Construction and The World of Manufacturing curricula was the first true attempt at providing a standardized curriculum for vocational/industrial arts teachers as there seemed to be no clear direction on what was being taught (Towers, 1966). Boe (2010) addressed a later attempt to provide a standardized curriculum and philosophy for vocational/industrial arts that was attempted. He stated that 21 professional educators gathered to work on and provide a unifying philosophy of vocational/industrial arts education and curriculum materials. This later became known as the Jackson's Mill curriculum project. The goal of this project was not only to include a unified rationale and direction for the study of industrial arts but also to determine how the profession would move forward (Boe, 2010). According to Wicklein (2006),

> The Jackson's Mill Industrial Arts Curriculum Theory document is considered as the starting point of the modern era of technology education. Of course there were other significant contributions that helped to set the stage for this document. . . . However, it was the Jackson's Mill document that provided the needed systemic refocus of the curriculum formerly known as industrial arts. (p. 25)

Although vocational/industrial arts is still known as a course of study in some schools today, the transition to technology education and now ETE has been instrumental in changing the way in which students are being prepared for the technologically challenging work force of the future (Boe, 2010). It is important to note that ETE is considered far different from the vocational/industrial arts program of study. Just as vocational/industrial arts had many differing definitions, so too does ETE, depending upon the person or organization.

It was in 1984 when the Vocational Education Act was renamed the Carl D. Perkins Vocational Education Act; the term *vocational/industrial arts education* was included as was the term *technical education programs* (Dortch, 2012). A philosophical shift began away from vocational/industrial arts education to one of a more technology-based paradigm. In doing so, the American Industrial Arts Association renamed itself the International Technology Education Association in 1985. This was the beginning of the technology education movement that has now become known as ETE. One definition of *technology education* is that it is a comprehensive, action-based educational program concerned with technical means, their evolution, utilization, and significance; with industry, its organization, personnel systems, techniques, resources and products; and their sociocultural impacts (P. N. Foster, 1994).

ETE has become an integral part of today's elementary, middle, and high school CTE programs across the country. ETE programs have been an element of the American high school experience and still are an integral part of an overall high school curriculum (Silverberg, Warner, Fong, & Goodwin, 2004). ETE provides students with an opportunity that begins at the elementary level in some states to examine different technological aspects of life, such as communications, manufacturing and production, transportation, construction, biotechnologies, and so forth, using the engineering design process as its foundation (Boe, 2010).

This growing body of research has established that an engineering design-focused curriculum helps students achieve technological literacy (Asunda & Hill, 2007; Dearing & Daugherty, 2004; Hailey, Erickson, Becker, & Thomas, 2005; ITEA, 2000; Wicklein, 2006). As schools have begun implementing an engineering design focus into new or existing technology education programs, it has been difficult for teachers and administrators to determine what they need to develop a high-quality technology education program (Advisory Committee on Engineering and Technology Education in Georgia, 2008). If research-based support materials are developed, facilities will be capable of supporting an engineering and technology curriculum based on national and state standards (Advisory Committee on Engineering and Technology Education in Georgia, 2008).

Engineering and Technology Education Curriculum

Engineering design or technology education? This is the critical issue continuing to plague the profession. Engineering design as a focus for technology education is beginning to find its way into the curriculum (Asunda & Hill, 2007; Dearing & Daugherty, 2004; Hailey et al., 2005; ITEA, 2000; Wicklein, 2006). This focus is designed to help students achieve technological literacy. The key difference between the two is that "the engineering design process uses analysis and optimization for mathematical prediction of design solutions" (Williams, 2010, p. 12). Mathematical modeling and experimentation then become an essential component to the design process by verifying solutions before the prototyping takes place.

Unfortunately, technology education or ETE is considered a marginal subject, an elective at the high school level, not of the mainstream curriculum. Worse, it is considered nonacademic within the present school structure in most states including Georgia. Arguably, status issues have plagued technology education or ETE since its early inception. However, there seems to be a shift in how technology education or ETE is viewed by some status-conferring groups, particularly in scientific and engineering communities. Among these groups are the National Science Foundation (NSF), the American Association for the Advancement of Science, the National Research Council, National Aeronautics and Space Administration (NASA), and the National Academy of Engineers; not only do these organizations have a positive view of technology education or ETE, they have also invested extensive resources in conceptualizing and validating the STL: Study for the Content of Technology.

The STL were initiated and executed by the ITEA (2000) and funded by both the NSF and NASA. There are 20 standards with 288 benchmarks that spell out what students must know and master from Grades K–12 in order to be deemed technologically literate (ITEA, 2000). The benchmarks are laid out at each grade level and provide a general guide for curriculum development. The benchmarks are specific, yet broad enough in nature to allow for flexibility as to how they are delivered and implemented at the classroom level.

According to the authors, the standards are both flexible and adaptable. The standards are broken down into five large areas: the nature of technology, technology and society, design, abilities for technological world standards, and designed world standards (ITEA, 2000). Standards 1–13 can be taught in other subjects outside of technology education or ETE. By structuring the standards in this manner, it allows for easy integration, both within and across curricula areas. For example, Standard 4 ("Student will develop an understanding of the cultural, social, economic, and political effects of technology") might be taught in a social studies class. Standard 10 ("Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving") could be taught in a technology education or ETE class also a physics class (ITEA, 2000).

Engineering by Design Curriculum

ITEA through the Center to Advance the Teaching of Technology and Science (CATTS), which is now the STEM Center for Teaching and Learning (STEM CTL), conducted one of the most comprehensive reform efforts in technology education, the Technology for All Americans Project. According to the ITEA (2009), the Center to Advance the Teaching of Technology and Science (CATTS) was created to strengthen professional development and advance technological literacy. In 1998 CATTS began with the following goals:

1. development of standards-based curricula,
2. teacher enhancement and professional development,
3. research concerning teaching and learning, and
4. curriculum implementation and diffusion (ITEA, 2009).

To achieve these goals, CATTS (STEM CTL) developed a consortium of stakeholders that would participate in, advise on, and implement products produced by the center. CATTS (1998) had six original charter members: Florida, Georgia, Kentucky, Michigan, North Carolina, and North Dakota. As many as 20 consortium states have worked with the center over the since its inception (ITEEA, 2014). The center produced curricular frameworks at the elementary, middle, and high school levels as well as provides in-service training for consortium states. In several cases, states adopted course titles and/or frameworks for their middle and high school programs (CATTS, 1998). According to ITEEA (2014), all model course guides produced by the center have been revised or updated in the past 10 years based on data collection and consortium input. At present, there are 11 frameworks and supporting curricula for grades K–12 (Figure 1).

	Grades		Course	Duration
CORE PROGRAM	K–2		EbD-TEEMS™	1-6 weeks
	3–6		EbD-TEEMS™ I^{3*} (6th Grade Capstone)	1-6 weeks
	6		*Exploring Technology*	18 weeks
	7		*Invention and Innovation*	18 weeks
	8		*Technological Systems*	18 weeks
	9		*Foundations of Technology*	36 weeks
	10–12	HS Choices	*Technology and Society*	36 weeks
	10–12		*Technological Design*	36 weeks
	11–12		*Advanced Design Applications* *	36 weeks
	11–12		*Advanced Technological Applications* *	36 weeks
	11–12		*Engineering Design* (Capstone)	36 weeks

Figure 1.1: EbD Course Titles K–12. Retrieved from http://www.iteea.org/images/EbD /Core_Sequence-TEEMS%20ONLY_2014sml.png

The national model program developed by the STEM Center for Teaching and Learning is known as Engineering by Design (EbD). EbD is the first standards-based national model for Grades K–12 that delivers technological literacy in a STEM context. EbD not only integrates the STL but also the Common Core Standards, Next Generation Science Standards, Principles and Standards for School Mathematics and Project 2061, Benchmarks for Science Literacy (ITEEA, 2014). Additionally, the curriculum has been mapped to the National Academy of Engineering's Grand Challenges for Engineering. In addition to the model course guides, the STEM CTL expanded the program with additional pathway extensions. These extensions, developed on a 4 credit sequence are: Robotics Engineering and Automation, Modeling and Simulation, and Science and Engineering. The purpose for development was to bring in business and industry expertise offering students the necessary skills to enter the identified technical areas (ITEEA, 2014).

The STEM CTL has established a network of teachers called the EbD Network to collaborate and conduct action research with regard to student learning and curriculum delivery. The EbD™ Network links schools and teachers that believe that the ingenuity of children is untapped, unrealized potential, that properly motivated, will lead to the next generation of technologists, innovators, designers, and engineers (ITEEA, 2014). STEM CTL, according to ITEEA (2014), has provided in-service training and model curricular frameworks for consortium members annually. As a consortium member, who Georgia is, supervisors are able to distribute EbD materials to all technology education teachers in their state. Each state also has the opportunity to identify teachers who are doing exemplary work with EbD course materials allowing them to train as EbD teacher effectiveness coaches. Data is consistently collected are used to improve course development and assessment techniques used by teachers in the classroom. In 2014, Georgia offered 7 EbD courses with over 7730 registered students (Georgia Department of Education, 2014).

Project Lead the Way Curriculum

Project Lead the Way (PLTW, 2014) is one of the more recent trends in curricula related to ETE. Currently, this trend relates to being in over 5,000 schools across the nation. According to PLTW (2014):

> Project Lead the Way (PLTW) is a 501(c) (3) nonprofit organization and the nation's leading provider of in-school STEM curriculum. Through world-class, activity-, project-, and problem-based curriculum, a high-quality teacher professional development model, and an engaged network of educators and corporate partners, PLTW helps students develop the skills needed to succeed in our global economy. PLTW courses are aligned with Common Core State Standards for Math and English Language Arts, Next Generation Science Standards, and other national and state standards. Courses and units are designed to complement math and science courses and in some instances are used as the core curriculum.

Richard Blais created PLTW in 1986, during the transitional period from industrial arts to technology education, while offering pre-engineering and digital electronics classes; he believed in the need to address the skills needed by the engineering profession and to expose students to the latest high-technology equipment and software (Boe, 2010). In 1997, PLTW was launched in 12 schools in upstate New York with the mission of preparing students to be successful in science, engineering, and engineering technology, called Pathway to Engineering (PTE). In 1998, PLTW went national with its program and included 30 additional states. Since that time, PLTW has developed a comprehensive organizational structure to help ensure participation and support for teachers. The key elements to this structure are a model curriculum, teacher training and development through affiliated colleges and universities, and a network of consultants across the country (Reid & Feldhaus, 2005). The curriculum in the PLTW (2014) program strives to make math and science relevant to students by engaging them in hands-on, real-world projects. Designed to develop skills that can be applied to complex situations and lead students to higher levels of learning PLTW delivers curriculum that lead to exciting new careers. This type of project-based learning enables students to synthesize and apply information to relevant, reality based situations related to their interests. PLTW’s pedagogical approach is embedded in case-, project-, or problem-based learning (Hull, 2012). Students undertake real-world projects to develop understanding and skills necessary to solve everyday life problems as well as the problems faced by engineering or health firms (Hull, 2012). According to PLTW (2014) students learn how to apply STEM knowledge, skills, and habits of mind to make the world a better place through innovation. The central focus of PLTW is pre-engineering education that focuses on preparing students for careers in engineering and engineering technology (Rogers, 2005).

PLTW’s (2014) Engineering program has a series of courses for both the middle school and high school. One distinct characteristic of the program is that courses are the same in all schools regardless of geographic location (Boe, 2010). PLTW Engineering is more than just another high school engineering program. It is about applying engineering, science, math, and technology to solve complex, open-ended problems in a real-world context (PLTW, 2014). PLTW is designed to be taught in conjunction with traditional math and science courses. The following eight courses are delivered at the high school level and provide students with in-depth, hands-on knowledge of engineering and technology-based careers:

1. Introduction to Engineering Design
2. Principles of Engineering
3. Digital Electronics
4. Aerospace Engineering
5. Biological Engineering
6. Civil Engineering and Architecture
7. Computer Integrated Manufacturing
8. Engineering Design and Development (PLTW, 2014)

According to Boe (2010), Mathias-Riegel in his study (2001) stated the PLTW program has quality standards insisted upon when a school signs a contract with the organization. In this contract, the school agrees to teacher training through PLTW and the formation of a partnership team made up of industry and college individuals. Teachers must also take a pre-assessment test prior to the intensive 75-hour 2-week training for every course they teach. This intensive training, in addition to a 1-year implementation of the curriculum, allows the teacher to transition to the master teacher level (Boe, 2010).

Georgia currently has 15 PLTW schools and one university affiliate. Each of the schools offers the PLTW engineering program, and the affiliate provides teacher training annually on these courses. With the STEM initiative and the newly revised engineering and technology high school pathway program standards having been cross-walked with PLTW courses, these programs are continuing to grow as offerings in high schools and college and career academies across the state.

Science, Technology, Engineering, and Mathematics

STEM has been gaining importance in grades K–12 across the nation since the early 2000's when the NSF first "coined" the term. Through communication and publication media, perceptions of STEM have evolved. STEM is now perceived as an academically focused curriculum in science, technology, engineering and mathematics – an advanced-placement curriculum geared to higher-achieving students (Hull, Career Pathways for STEM Technicians, 2012). STEM may be viewed as an interdisciplinary approach to learning; the opportunity to break free from the silo's mentality of teaching these subjects that is becoming popular in the educational arena. The study of STEM through the interdisciplinary approach offers students a chance to experience the integrated world they live in rather than learning and practicing segmented pieces of it (Boe, 2010).

Interest in the study of STEM has been around since the colonial era when Benjamin Franklin wrote that topics such as grafting, planting, inoculating, commerce, manufacturers, trade, force and effect of engines and machines, and mechanics ought to be taught (Salinger & Zuga, 2009). Beginning with the establishment of the first technological university in 1824, Rensselaer Polytechnic Institute, the training of teachers in the manual arts began as part of what are now engineering programs. It was in 1963 with the passage of the Vocational Education Act that the federal government vested its interest through financial support in what is now known as CTE. It was in the early 2000s, however, that the NSF officially coined the STEM acronym and began funding initiatives that included the creation of standards such as the STL (ITEA, 2007) and various curricula integrating problem-based inquiry and engineering design. Dugger (2010) attributed the evolution, implementation, and momentum of STEM in the United States to the emphasis of the NSF, federal funding, some states including technology and engineering offerings like Georgia, the evolution and implementation of content standards in all areas for K–12, and the ITEEA name change.

Today, however, there is constant buzz that the United States is faced with a major crisis as related to STEM. For more than a decade, experts across the nation have placed an emphasis on the fact that there is a shortage of professionals entering STEM-related careers. Due to the shortage, it is predicted that the United States will suffer from a loss of productivity and gross national product and a very real lowering of the standard of living in the United States if attention is not given to the STEM disciplines (Daugherty, 2009).

Recognizing the gap taking place in K–12 schools as well as at the collegiate level, the National Governors Association released the publication *Building a Science, Technology, Engineering and Math Agenda* in 2007 with recommendations for the K–12 educational system to ensure all students graduate with high-level STEM competencies (Boe, 2010). Recommendations were to align rigorous K–12 STEM education requirements to meet the expectations of postsecondary education and the workplace, develop statewide capacity for improved K–12 STEM teaching and learning, and support new models that focus rigor and relevance to ensure every student is STEM literate upon graduation (National Governors Association, 2007). STEM education allows students not only to build upon a foundation established at the elementary level in many states but also to carry this increase in skill and knowledge throughout their postsecondary education career pathway.

True and authentic integrative K–12 STEM education may be a critical solution in preparing students for success as they move forward in the 21st century with essential college and career-ready skills in critical thinking, problem solving, systems thinking, communicating, and collaborating (Hotek & Greenhalgh, 2013). Hotek and Greenhalgh (2013) found that problem solving, critical thinking, effective communication, and being able to work collaboratively in a diverse team setting received an above-average rating of importance. This information assisted Georgia's CTAE Department in beginning the revision process of state standards to ensure students would be provided the necessary career-ready skills preparing them for college and career.

Currently, the Georgia Department of Education (2014a) is dedicated to preparing students for 21st-century workplace careers by providing high-quality educational opportunities in STEM fields. Of the nearly 1 million Grade 6–12 students in Georgia, almost half are enrolled in one or more CTAE courses. Although all CTAE programs address some aspect of science and mathematics and may not include the T or E, they do address STEM-related careers. In a very real sense, all occupationally oriented CTE is STEM related (Stone & Lewis, 2012).

Georgia offers the opportunities for all students to identify, explore, and attain their career goals through its 17 CTAE Career Clusters and their associated programs of study. Within Georgia's STEM Career Cluster programs of study or pathway offerings of Engineering and Technology, Engineering Drafting and Design, and Electronics, high school pathways are available to students. With over 18,000 high school students enrolled in the STEM Career Cluster ETE high school pathway and another 91,000 middle school students enrolled in ETE connection courses in 2013, Georgia is providing STEM pedagogy in an interdisciplinary approach that bridges students' education, increasing their 21st-century skill and technological literacy. These courses are designed to develop technological literacy as part of the students' fundamental education through an activity-based study of past, present, and future technological systems and their resources, processes, and impact on society (Georgia Department of Education, 2014a). The standards of the pathway courses and instructional pedagogy correlate to the definition of STEM in Georgia, which is an integrated curriculum (in contrast to science, technology, engineering, and mathematics taught in isolation) that is driven by problem solving, discovery, exploratory project/problem-based learning, and student-centered development of ideas and solutions (Georgia Department of Education, 2014a). Georgia's students are being afforded the opportunity to become innovators and technologically proficient problem solvers as they are being prepared for college and careers.

Summary

The review of related research and literature showed the added value of CTE in a student's education. Having gone through many transformations since the late 1800s, CTE's relevance is just as important today as it was then in preparing students for their interests in life. The ETE pathway has experienced the same transformations, from manual/industrial arts to technology education and now ETE. With the focus on integrating content and practices in the STEM fields, ETE's STL provide the most engineering content of the national STEM education standards. Georgia has adopted these standards as the foundation of its newly revised STEM Career Cluster ETE high school pathway.

CHAPTER THREE

RESEARCH DESIGN AND METHODS

Introduction

Chapter 3 explains the research methods used to execute the study, giving special emphasis to the analysis of data. The purpose of the study and research questions are first presented, followed by an overview of descriptive statistics, research design, instrumentation, sample selection, data collection, and data analysis procedures utilized in the study.

Statement of the Problem

The purpose of this study was to investigate and compare the perceptions affiliated with the STEM Career Cluster ETE high school pathway as perceived by Georgia STEM Career Cluster ETE high school teachers and associated CTAE administrators and to determine whether differences exist between the two major stakeholder groups and its effect on implementation within their district and schools. The following research questions were used to guide this descriptive research study:

1. Is there a significant difference in the perception of ETE teaching methodology between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
2. Is there a significant difference in the perception of ETE curriculum content between Georgia ETE high school teachers and CTAE administrators as

measured by the Characteristics of Engineering and Technology Education Survey?

3. Is there a significant difference in the perception of STEM integration in the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
4. Is there a significant difference in the perception of how to improve the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?

Population

The population for this study included Georgia STEM Career Cluster ETE high school teachers and CTAE administrators as identified by Georgia's CTAE Resource Network (CTAERN) education database. The CTAERN database is a web-based recordkeeping site that houses curriculum and staff development opportunities and allows teachers to keep records of career and technical student activities. Local school systems as well as the Georgia Department of Education's CTAE Department are able to access the database to send e-mails to targeted groups to promote better communications throughout Georgia. A census approach to sampling is very effective for small populations and eliminates sampling error while attempting to provide data on all individuals in a population. In cases of small populations, it is recommended that researchers sample the entire population in order to achieve desirable results (Israel, 2014). The survey instrument was e-mailed to 419 participants that included 234 ETE high school teachers and 185 CTAE administrators. An e-mail cover letter (see Appendix B) was sent to explain the purpose and scope of the study to each e-mail address and provided the website where the potential participants were to fill out the survey instrument using SurveyMonkey. SurveyMonkey is a confidential web-based survey collection tool that offers an innovative way to gather data with quicker response times and the possibility of reaching a larger target group.

No tests or experimental procedures were used in this study. With regard to protecting human subjects, a human subject's exemption was received through the Office of Research Compliance at Clemson University. To protect each responding participant, the identity option was disabled within the survey accounts website. Consequently, each participant's identity remained anonymous. Consent was obtained when respondents participated (logged on) in the CETES questionnaire.

Instrument

The data were collected using SurveyMonkey, a web-based survey program. Other past studies such as the 1991 study conducted by Dr. Daugherty, Dr. Wicklein' s study in 1993, and Dr.'s Hill, Wicklein and Daugherty in 1996 utilizing the CTES had been conducted using mailings through the U.S. Postal Service or other manual delivery service. Using a web-based design, the participants were contacted using their school e-mail accounts and invited to visit a website that allowed them to answer questions on the survey instrument. The data were downloaded from the website and then used for analysis.

The original CTES questionnaire was developed by Dr. Michael Keith Daugherty and Dr. Robert C. Wicklein and was based on the content model for the study of technology (Daugherty, 1991). A pilot study was conducted establishing the instrument's reliability and validity using a Cronbach's coefficient alpha test. The purpose of the questionnaire was to allow all respondents the opportunity to express their perceptions of the characteristics exemplifying the technology education discipline (Daugherty, 1991). The original CTES was a 2-page 38-item questionnaire. The CTES questionnaire with slight modifications was utilized in later studies by Daugherty, Hill, and Wicklein (1996) and more recently by Rogers (2012) to examine a pre-engineering program, PLTW, and its use by teachers in the state of Indiana.

The researcher was granted permission from Dr. Michael K. Daugherty to utilize the CTES and to make modifications that would be suitable for the intended purpose of the study as it relates to Georgia. The title of the survey was changed to the Characteristics of Engineering and Technology Education Survey (CETES) to reflect the title of Georgia's high school ETE pathway. The questionnaire was divided into five subsequent sections. Section I requested demographic data including job function, whether the ETE pathway was offered, the current courses the educator was teaching, whether the educator had been trained in any PLTW pre-engineering course, use of ITEEA's EbD curriculum, program certification, total years teaching, type of community in which the school is located, highest degree attained and in which field, and age of respondent. Section II contained 11 items related to the perception of the teaching methods used in the ETE pathway. Section III contained 14 items related to the perception of the content characteristics in the ETE pathway. Section IV contained five items related to the perception of the need to integrate STEM in the ETE program. Section V included five items related to actions that the STEM ETE profession can take to improve perceptions of the field.

Responses to the items on the CETES were marked using a 5-point Likert-type rating scale: 1 (*strongly disagree*), 2 (*disagree*), 3 (*no opinion*), 4 (*agree*), 5 (*strongly agree*). A rating scale is a tool for systematic appraisal, either by the respondent or an observer. Rating scales enable researchers to record and quantify respondents' judgments of people as well as all kinds of products (Heiss, 1994). Invented by the educator Rensis Likert while at Columbia University completing his thesis, the 5-point Likert-type scale was chosen due to the balance that is provided on both sides of the neutral option (3), which indicated a *no opinion* response.

The last three questions that were added to the 52-item questionnaire were open-ended and allowed each respondent to elaborate:

- The goal of this study is to improve the STEM engineering and technology education pathway in Georgia. To address this goal, what are some limitations for successful implementation of the Engineering and Technology pathway in Georgia?
- What are some of the strengths of the STEM Engineering and Technology pathway in Georgia?
- Please explain your perception of the importance of the STEM Engineering and Technology education pathway in the overall school curriculum.

This provided the opportunity for respondents to identify and address any issues, challenges, limitations, strengths, weaknesses, and perceptions that were not previously identified in the survey instrument.

Data Collection and Procedures

The CETES survey was distributed using Dillman, Smyth, and Christian's (2009) total design method schedule. Individuals received five communications from the researcher via e-mail, consistent with Dillman et al.'s total design method of four hard-copy contacts. Using e-mails and a website as the data collection vehicle proved to be efficient, productive, and informative. Respondents to the survey instrument supported Poole and Loomis's (2009) findings, which statistically supported Internet survey methods to be equal to the previously used paper-and-pencil survey.

The survey was uploaded to SurveyMonkey on May 21, 2013. A total of 419 e-mails were distributed. The survey was released to these participants on June 10, 2013. Eleven e-mails were immediately rejected by the website as invalid. Thus, a total of 408 surveys were distributed across Georgia. Following Dillman et al.'s (2007) total design method, participants received four follow-up e-mails over the next six weeks requesting participation, including a final appeal on November 23, 2013, just before the expiration of Clemson University's Institutional Review Board approval. Responses were collected until November 30, 2013. According to Krejcie and Morgan's (1970) method for determining sample size for research activities, the statistically representative sample size for this study was determined to be 205. Two respondents chose to opt out of the survey; thus, the final results of the study yielded a total of 243 respondents with completed surveys that were collected for analysis, for a response rate of 59.5%. Therefore, the results of this study can be generalized to the entire population.

Data were recorded and analyzed using SPSS. Descriptive statistics, including mean, median, and standard deviation, were computed to describe the group results of Georgia STEM Career Cluster ETE high school teachers and CTAE administrators regarding Georgia's ETE high school pathway. Survey results furnished the basis for the testing of the null hypotheses. The analysis of the null hypotheses was reported by computing the average response rate on a 5-point Likert-type scale. This descriptive statistic was addressed by evaluating individual Georgia STEM Career Cluster ETE high school teachers' and CTAE administrators' responses to Items 13–49 in Sections II–V of the CETES. The responses were evaluated on a scale of assigned values of 1 (*strongly disagree*) through 5 (*strongly agree*). A value of 3 indicated *no opinion*.

Analysis of variance (ANOVA) was used to analyze the perceptions of the Georgia STEM Career Cluster ETE teachers and CTAE administrators regarding their awareness, views, and attitudes toward the ETE high school pathway in Georgia schools. These data were presented in an ANOVA summary table where the F values of the groups could be compared to the tabled critical values in order to determine whether there was a significant difference in values of the groups. According to Howell (2002), ANOVA is used to test hypotheses about differences between two or more arithmetic means. Researchers can use a t test when two or more means occur. However, conducting multiple t tests can lead to an inflated Type I error rate. Researchers use ANOVA to test for the differences among means because it will not increase the Type I error rate (Howell, 2002).

Analysis of Data

Respondents to the survey included 243 administrators and teachers. Administrators (*n* = 105, 43.2% of the sample) included CTAE directors, general administrators, and supervisors from across Georgia. Teachers (*n* = 138; 56.8% of the sample) included classroom teachers, lecturers, and professors. Respondents were also asked if they had attained certification in PLTW pre-engineering courses. Only 19 respondents (7.8%) indicated that they had attained this certification. Participants were polled about the number of years they had served in their current position as well as the number of years they had served in the education field. Participants were asked to select a range of years. Therefore, it is not possible to provide a mean number of years regarding position or longevity in the education field. The distribution of current years of service from respondents' data was 1–3 years (*n* = 57, 23.5%), 4–8 years (*n* = 60, 24.7%), 9–15 years (*n* = 46, 18.9%), and over 15 years (*n* = 37, 15.2%). Forty-three respondents (17.7%) did not provide an answer to the number of years of service in their current positions. On the number of years of service in the education field, the distribution of responses was 1–3 years (*n* = 9, 3.7%), 4–8 years (*n* = 22, 9.1%), 9–15 years (*n* = 44, 18.1%), and over 15 years (*n* = 125, 51.4%). Forty-three respondents (17.7%) did not provide an answer to the number of years of service in the education field.

Analysis of number of years in current position by status as either an administrator or a teacher indicated a statistically significant difference ($\chi^2[3] = 8.41$, p =

.038), with teachers more often having greater number of years of experience in their current positions than administrators. A second analysis was performed on number of years in the education field, which also indicated that teachers were more likely to have more experience in the field than administrators (χ^2[3] = 14.87, *p* = .002).

The survey also polled the highest level of education attained by the respondents. Two hundred of the participants provided information on this question: some college but no degree (*n* = 1, 0.4%), associate's degree (*n* = 2, 0.8%), bachelor's degree (*n* = 26, 10.7%), and graduate degree (*n* = 171, 70.4%). A chi-square analysis was conducted to determine if there were differences between administrators and teachers on highest level of education. A statistically significant difference was found, indicating the administrators were more likely to have a graduate degree than the teachers (χ^2[3] = 14.86, *p* = .002).

Age was also provided by respondents by selecting an age range. Only 198 indicated their age on the survey, with the following distribution: 21–29 years (*n* = 6, 2.5%), 30–39 years (*n* = 37, 15.2%), 40–49 years (*n* = 59, 24.3%), 50–59 years (*n* = 86, 35.4%), and over 60 years of age (*n* = 10, 4.1%). A chi-square analysis indicated there was no statistically significant difference in age between administrators and teachers (χ^2[4] = 7.40, *p* = .116).

Teachers and administrators were also polled about the types of communities in which they worked; 48 respondents indicated their community was a city or urban community, 70 identified their community as suburban, and 82 indicated their community as rural. Forty-three respondents did not provide information on this question.

Participants were polled about the presence of the STEM Career Cluster ETE pathway in their school or district. All 243 respondents completed this item, with 191 (78.6%) indicating the ETE pathway was present in their school or district. The respondents were further polled about which of the primary engineering pathways were implemented: Engineering and Technology (n = 115), Engineering Drafting and Design (n = 10), Electronics (n = 4), Manufacturing (n = 5), and Energy (n = 4). Although 191 individuals reported that an ETE pathway was present, only 138 provided a response to the follow-up question regarding which primary pathway was present. Participants also provided information about the industry certification status of the ETE programs in their schools, with 28% (n = 68) indicating that the school had been awarded such certification. Participants indicated their use of the International Technology and Engineering Educators Association EbD curriculum. Of the 243 respondents, 45 (18.5%) indicated they employed the curriculum in their classrooms.

In addition, four subscales were analyzed utilizing the ANOVA to answer the research questions of the study: teaching methodology, curriculum content, STEM integration, and improvements to ETE. Reliability analyses (Cronbach's alpha) for the subscales were conducted. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items is as a group. It is considered to be a measure of scale reliability. When conducting the analysis of reliability for the methodology and content subscales, some items were removed to increase the internal consistency of the scales. For methodology (Items 13–23), Item 24 was removed as it increased reliability from .918 to .941. For content (Items 25–39), Items 27, 38, and 39 were removed to increase reliability from .917 to .940. For STEM integration (Items 40–44), the alpha was .849. For ETE (Items 45–49), the alpha was .873.

According to D. L. Foster (2009), it is common to use a probability value (*p* value) when testing for significance. The *p* value ranges from 0.0 to 1.0, which represents how improbable a statistic would be if the hypothesis being tested were true. The *p* value was established at the $p \leq .05$ level of significance for the study.

Summary

Chapter 3 described the design of the study, its population, the variables, and the data collection process. An e-mail cover letter and a link to a website for the survey instrument were distributed. Survey data were collected from the website. The demographic data of the study were discussed. Data analysis techniques and null hypotheses were discussed. Chapter 4 contains the results and analysis using tables and narrative text to present the data.

CHAPTER FOUR

DATA ANALYSIS

Introduction

The purpose of this study was to investigate and compare the perceptions of the STEM Career Cluster ETE high school pathway as discerned by Georgia STEM Career Cluster ETE high school teachers and CTAE administrators and to determine whether differences existed between the two major stakeholder groups. Chapter 4 presents the results of the CETES.

Research Questions

The following research questions were used to guide this descriptive research investigation:

1. Is there a significant difference in the perception of ETE teaching methodology between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
2. Is there a significant difference in the perception of ETE curriculum content between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
3. Is there a significant difference in the perception of STEM integration in the ETE high school pathway between Georgia ETE high school teachers and

CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?

4. Is there a significant difference in the perception of how to improve the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?

Response Data

The CETES was used in this research process to elicit responses from participants in the field of CTAE, to answer the four research questions. The CETES (see Appendix E) was based on the results of a state-wide pilot study created by Daugherty and Wicklein in 1991 to determine the perceived characteristics affiliated with the technology education discipline as discerned by technology education stakeholders. A total of 419 possible participant e-mails were identified using Georgia's CTAERN database. The CTAERN database is a web-based recordkeeping site that houses curriculum and staff development opportunities and allows teachers to keep records of career and technical student activities. Local school systems as well as the Georgia Department of Education's CTAE Department are able to access the database to send e-mails to targeted groups promoting better communications throughout Georgia as related to CTAE. The distribution included 234 ETE high school teachers and 185 CTAE administrators. The questionnaire was released to these participants on June 10, 2013. Eleven e-mails were immediately rejected by the website as invalid. Thus, a total of 408 CETES surveys were distributed across Georgia. An e-mail cover letter (see Appendix B) was sent to each e-mail address to explain the purpose and scope of the study and provided the website address where the potential participants were to fill out the survey instrument using SurveyMonkey. Two respondents chose to opt out of the survey; thus, the final results of the study yielded a total of 243 respondents with completed surveys that were collected for analysis, for a response rate of 59.5%. Group response rates and percentage breakdowns are outlined in Table 4.1.

Table 4.1
*Job Function (*N *= 243)*

Job function	*f*	%	Valid %
CTAE Administrator	105	43.2	43.2
ETE HS Teacher	138	56.8	56.8
Total	243	100.0	100.0

Tables 4.2–4.15 present the findings and analysis of the demographic data collected from the CETES. Table 4.2 reflects demographic data collected about the presence of the STEM Career Cluster ETE pathway in the respondent’s school or district. All 243 respondents completed this survey item, with 191 (78.6%) indicating the ETE pathway was present in their school or district.

Table 4.2
*STEM Career Cluster ETE Pathway Offerings (*N *= 243)*

ETE pathway present?	*f*	%	Valid %
Yes	191	78.6	78.6
No	52	21.4	21.4
Total	243	100.0	100.0

Table 4.3 reflects follow-up data to the previous question regarding ETE pathway offerings. Although 191 individuals reported the ETE pathway as present, only 138 indicated which primary pathway was being implemented. These 138 respondents represent the ETE high school teacher sample.

Table 4.3
*ETE Teacher Predominant Pathway of Instruction (*N *= 138)*

Predominant pathway of instruction	*f*	%	Valid %
Engineering and Technology	115	78.6	100.0
Engineering Drafting and Design	10	4.1	100.0
Electronics	4	1.6	100.0
Manufacturing	5	2.1	100.0
Energy	4	1.6	100.0
Total	138	100.0	100.0

Two major curricula that are offered for teaching the STEM Career Cluster ETE high school pathway are PLTW and ITEEA’s EbD. Table 4.4 reflects demographic data on whether either curriculum’s materials were being utilized in the Georgia ETE pathway. Only 200 of the 243 respondents answered these questions, with 19 (7.8%) using the PLTW curriculum and 45 (18.5%) using the EbD curriculum. This is significant in that Georgia is an EbD Consortium state, where a fee in excess of $25,000 is paid each year for access to the EbD curriculum for use in the ETE programs, also in that PLTW is attempting to market its program more heavily in the state.

Table 4.4
*PLTW or EbD Curriculum (*N *= 200)*

Curriculum	*f*	%	Valid %	Cumulative %
PLTW				
Yes	19	7.8	9.5	9.5
No	130	53.5	65.0	74.5
N/A	51	21.0	25.5	100.0
EbD	200	82.3	100.0	
Yes	45	18.5	22.5	22.5
No	101	41.6	50.5	73.0
N/A	54	22.2	27.0	100.0
Total	200	82.3	100.0	

The state of Georgia has established a system for the certification of ETE programs. This program of certification is intended to recognize those programs that maintain the highest standards. The ETE certification process consists of four phases: accessing the certification information on the Internet, program self-evaluation, onsite team evaluation, and maintaining certification (Georgia Department of Education, 2014b). In addition to this process, local school systems can apply through the consolidated application each spring requesting initial certification funding that is dependent upon the state-approved fiscal year budget but has been consistent at $10,000.

A system may also apply for a recertification funding amount every five years, which has been consistent at $5,000. Table 4.5 reflects data on whether the ETE high school pathway program is certified. Only 200 of the 243 respondents responded (82.3%) to this question, with 68 (28%) indicating the program as being or having been certified.

Table 4.5
*ETE Program Certification (*N *= 200)*

ETE program certification?	*f*	%	Valid %
Yes	68	28.0	34.0
No	132	54.3	66.0
Total	200	82.3	100.0

Tables 4.6 and 4.7 reflect respondents' demographic data on the number of years in their current position. Only 200 of the 243 respondents to the questionnaire responded to this question, thus yielding an 82.3% return rate. An analysis of number of years in current position by status as either an administrator or a teacher indicated a statistically significant difference ($\chi^2[3] = 8.41$, $p = .038$), with teachers more often having more years of experience in their current positions than administrators.

Table 4.6
*CTAE Administrators' Years in Current Position (*N *= 70)*

Years in current position	*f*	%	Valid %
1–3	27	38.6	
4–8	19	27.1	
9–15	17	24.3	
15+	7	10.0	
Total	70	100.0	35.0

Table 4.7
*ETE Teachers' Years in Current Position (*N *= 130)*

Years in current position	*f*	%	Valid %
1–3	30	23.1	
4–8	41	31.5	
9–15	29	22.3	
15+	30	23.1	
Total	130	100.0	65.0

Tables 4.8 and 4.9 reflect demographic data on number of years employed in the education field. A second analysis was performed on number of years in the education field, which again indicated teachers were more likely to have more experience in the field than administrators ($\chi^2[3] = 14.87$, $p = .002$).

Table 4.8
CTAE Administrators' Total Years in Education (N = 70)

Total years in education	*f*	%	Valid %
1–3	0	0.0	
4–8	3	4.3	
9–15	12	17.1	
15+	55	78.6	
Total	70	100.0	35.0

Table 4.9
ETE Teachers' Total Years in Education (N = 130)

Total years in education	*f*	%	Valid %
1–3	9	6.9	
4–8	19	14.6	
9–15	32	24.6	
15+	70	53.8	
Total	130	100.0	65.0

Tables 4.10 and 4.11 reflect demographic data identifying the type of community in which the respondent's school is located. A chi-square analysis was conducted to determine if there were differences between administrators and teachers on type of community. A statistically significant difference was found, indicating the administrators were more likely to be located in rural communities ($\chi^2[2] = 15.33$, $p = .001$).

Table 4.10
*CTAE Administrators' Type of School District (*N *= 70)*

Type of school district	*f*	%	Valid %
City or urban	15	21.4	
Suburban	14	20.0	
Rural	41	58.6	
Total	70	100.0	35.0

Table 4.11
*ETE Teachers' Type of School District (*N *= 130)*

Type of school district	*f*	%	Valid %
City or urban	33	25.4	
Suburban	56	43.1	
Rural	41	31.5	
Total	130	100.0	65.0

Tables 4.12 and 4.13 reflect demographic data of the 200 participants who provided information regarding highest degree received. A chi-square analysis was conducted to determine if there were differences between administrators and teachers on highest degree received. A statistically significant difference was found, indicating the administrators were more likely to have a graduate degree than the teachers ($\chi^2[3] = 14.86$, $p = .002$).

Table 4.12
*CTAE Administrators' Highest Degree Received (*N *= 70)*

Highest degree received	*f*	%	Valid %
Some college but no degree	0	0.0	
Associate's degree	0	0.0	
Bachelor's degree	1	1.4	
Graduate degree	69	98.6	
Total	70	100.0	35.0

Table 4.13
*ETE Teachers' Highest Degree Received (*N *= 130)*

Highest degree received	*f*	%	Valid %
Some college but no degree	1	0.8	
Associate's degree	2	1.5	
Bachelor's degree	25	19.2	
Graduate degree	102	78.5	
Total	130	100.0	65.0

Tables 4.14 and 4.15 reflect respondents' age ranges. Only 198 respondents indicated their age on the survey. A chi-square analysis indicated there was no statistically significant difference in age between administrators and teachers ($\chi^2[4] = 7.40$, $p = .116$).

Table 4.14
*CTAE Administrators' Age (*N *= 70)*

Age in years	*f*	%	Valid %
21–29	0	0.0	
30–39	12	17.1	
40–49	22	31.4	
50–59	35	50.0	
60+	1	1.4	
Total	70	100.0	35.4

Table 4.15
*ETE Teachers' Age (*N *= 128)*

Age in years	*f*	%	Valid %
21–29	6	4.7	
30–39	25	19.5	
40–49	37	28.9	
50–59	51	39.8	
60+	9	7.0	
Total	128	100.0	64.6

To gather the necessary data to discern the perceptions of Georgia CTAE administrators and ETE high school pathway teachers, participants were asked to respond to 37 statements based on a 5-point Likert-type scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Identical calculations were completed that included number, range, mean, and standard deviation along with the statistical analysis results of a one-way

ANOVA test for significance. The analysis of the scores for both groups is presented in Table 4.16. Tables 4.17 and 4.18 reflect each group's ratings of survey statements in descending order by mean score for each question. Though the survey results did not indicate agreement regarding the highest rated perception, it can be noted that Item 24 ("In engineering and technology education the modular method for program delivery should be dominant") had the lowest mean (M = 2.74, SD = 1.19).

Table 4.16

Perceived Characteristics of All Stakeholders, Including ANOVA Summary

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
13	Engineering and technology education emphasizes problem solving.	69	4.30	1.090	1–5	126	4.71	.668	1–5	10.61 (.001)
14	Engineering and technology education provide exploratory activities that include modeling, graphing, and production.	69	4.29	.972	1–5	129	4.62	.698	1–5	7.59 (.006)
15	Engineering and technology education instruction is goal oriented.	69	4.20	.994	1–5	127	4.47	.700	1–5	4.89 (.028)
16	Cooperative learning and small group instruction is encouraged in engineering and technology education.	69	4.30	.912	1–5	128	4.65	.596	1–5	10.17 (.002)
17	Verbal activity in the form of presentations and discussion of concepts and issues is emphasized in engineering and technology education.	69	4.03	.954	1–5	129	4.38	.652	1–5	9.32 (.003)
18	Student cognitive strategies have clearly been developed.	69	3.87	1.010	1–5	129	4.09	.833	2–5	2.77 (.098)
19	Engineering and technology education emphasizes interdisciplinary activities.	69	4.20	.867	1–5	129	4.43	.758	1–5	3.53 (.062)
20	A broad range of assessment strategies (design portfolios, project work, performance testing) are used in engineering and technology education.	69	4.12	.948	1–5	129	4.63	.650	1–5	20.05 (.001)

Table 4.16
Perceived Characteristics of All Stakeholders, Including ANOVA Summary (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
21	Engineering and technology education lessons are hypothesis driven.	69	3.83	.939	1–5	129	3.82	.861	2–5	.001 (.974)
22	Engineering and technology education provides activity-oriented laboratory instruction that reinforces abstract concepts with concrete examples.	69	4.25	.914	1–5	129	4.56	.611	2–5	8.19 (.005)
23	Engineering and technology education has an organized set of concepts, processes, and systems.	69	4.06	.938	1–5	129	4.31	.789	1–5	4.02 (.046)
24	In engineering and technology education the modular method for program delivery should be dominant.	69	2.93	1.190	1–5	129	2.64	1.190	1–5	2.58 (.110)
25	Engineering and technology education content is based on an organized set of concepts, processes, and systems that are uniquely technological.	69	3.86	.928	1–5	129	4.19	.693	2–5	8.04 (.005)
26	Engineering and technology education content is based on knowledge about the development of technology and its effect on people, the environment, and culture.	69	4.06	.820	1–5	129	4.36	.694	2–5	7.32 (.007)
27	A portion of the engineering and technology education instructional content is based on using biological organisms to modify products.	69	3.54	.815	1–5	129	3.43	.998	1–5	.616 (.434)

Table 4.16

Perceived Characteristics of All Stakeholders, Including ANOVA Summary (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
28	A portion of the engineering and technology education instructional content is based on using resources to transfer information and communication.	69	3.96	.652	1–5	129	4.37	.546	2–5	22.71 (.001)
29	A portion of the engineering and technology education instructional content is based on combining and modifying resources in standard stocks, goods, and structures (production).	69	3.88	.832	1–5	129	4.22	.615	2–5	10.71 (.001)
30	A portion of the engineering and technology education instructional content is based on the study of transportation systems.	69	3.70	.845	1–5	128	4.19	.750	1–5	17.61 (.001)
31	The engineering and technology education curriculum assists students in developing insight, understanding, and application of technological concepts, processes, and systems.	69	4.09	.781	1–5	129	4.58	.511	3–5	28.77 (.001)
32	The engineering and technology education curriculum allows for the application or tools, materials, machines, processes, and technical concepts.	69	4.26	.834	1–5	129	4.63	.501	3–5	14.94 (.001)
33	The engineering and technology education curriculum aids in the development of student skills, creative abilities, positive self-concepts, and individual potential in engineering and technology.	69	4.23	.825	1–5	129	4.60	.491	4–5	15.87 (.001)

Table 4.16

Perceived Characteristics of All Stakeholders, Including ANOVA Summary (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
34	The engineering and technology education curriculum aids in the development of student problem-solving and decision-making skills.	69	4.30	.845	1–5	129	4.72	.500	2–5	18.98 (.001)
35	Engineering and technology education helps prepare students for lifelong learning in a technological society.	69	4.19	.772	1–5	129	4.64	.481	4–5	26.01 (.001)
36	Students enrolled in the engineering and technology education pathway use math and science skills to perform tasks.	69	4.39	.826	1–5	129	4.67	.473	4–5	8.90 (.003)
37	The engineering and technology education teacher assists students to see the connection between scientific and math skills and its applications to engineering and technology.	69	4.30	.828	1–5	129	4.66	.476	4–5	14.65 (.001)
38	Engineering and technology education should focus on the needs of special education students.	69	3.74	.980	1–5	129	3.61	.995	1–5	.737 (.392)
39	Engineering and technology education should focus on the college-prep needs of students.	69	3.77	1.030	1–5	129	4.10	.874	1–5	5.74 (.018)
40	Engineering and technology education provides an avenue for applying concepts learning in math and science.	69	4.33	.816	1–5	129	4.64	.497	3–5	11.01 (.001)
41	Engineering and technology education should be available to all students who enroll in math and science.	69	4.25	.847	1–5	129	4.53	.674	2–5	6.86 (.010)

Table 4.16

Perceived Characteristics of All Stakeholders, Including ANOVA Summary (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
42	Engineering and technology education is an applied science.	69	4.49	.896	1–5	129	4.41	.725	1–5	3.58 (.060)
43	The engineering and technology education pathway is guided by the technological literacy needs of the students.	69	4.03	.766	1–5	129	4.16	.808	2–5	1.28 (.260)
44	The engineering and technology education pathway reflects business and industry needs.	69	4.04	.794	1–5	129	4.19	.670	2–5	1.78 (.183)
45	Engineering and technology education teachers should form interdisciplinary committees to develop integration strategies.	69	4.17	.822	1–5	129	4.12	.820	2–5	.166 (.684)
46	Engineering and technology education programs should continue to revise curriculum strategies to more accurately reflect mathematics and science concepts.	69	4.13	.922	1–5	129	4.29	.698	1–5	1.79 (.182)
47	Leaders in the engineering and technology education profession should make presentations at state and national mathematics and science conferences addressing the need for integration.	69	4.16	.851	1–5	129	4.20	.711	2–5	.137 (.712)
48	Engineering and technology education professionals should conduct research to ascertain the integration needs of math and science teachers.	69	4.10	.843	1–5	129	4.12	.725	2–5	.017 (.897)

Table 4.16

Perceived Characteristics of All Stakeholders, Including ANOVA Summary (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
49	The engineering and technology education discipline should develop strategies for overcoming stereotypical perceptions often held by administrators, counselors, and secondary education faculty members.	69	4.16	.868	1–5	128	4.52	.699	2–5	9.80 (.002)

Table 4.17

*Perceived Characteristics of CTAE Administrators in Priority Order by Mean Ratings (*N *= 69)*

Q	Statement	*M*	*SD*
42	ETE is an applied science.	4.49	0.896
36	Students enrolled in the ETE pathway use math and science skills to perform tasks.	4.39	0.826
40	ETE provides an avenue for applying concepts learning in math and science.	4.33	0.816
13	ETE emphasizes problem solving.	4.30	1.090
16	Cooperative learning and small group instruction is encouraged in ETE.	4.30	0.912
34	The ETE curriculum aids in the development of student problem-solving and decision-making skills.	4.30	0.845

Table 4.17

*Perceived Characteristics of CTAE Administrators in Priority Order by Mean Ratings (*N *= 69)* (*continued*)

Q	Statement	*M*	*SD*
37	The ETE teacher assists students to see the connection between scientific and math skills and its applications to engineering and technology.	4.30	0.828
14	ETE provides exploratory activities that include modeling, graphing, and production.	4.29	0.972
32	The ETE curriculum allows for the application or tools, materials, machines, processes, and technical concepts.	4.26	0.834
22	ETE provides activity-oriented laboratory instruction that reinforces abstract concepts with concrete examples.	4.25	0.914
41	ETE should be available to all students who enroll in math and science.	4.25	0.847
33	The ETE curriculum aids in the development of student skills, creative abilities, positive self-concepts, and individual potential in engineering and technology.	4.23	0.825
15	ETE instruction is goal oriented.	4.20	0.994
19	ETE emphasizes interdisciplinary activities.	4.20	0.867
35	ETE helps prepare students for lifelong learning in a technological society.	4.19	0.772
45	ETE teachers should form interdisciplinary committees to develop integration strategies.	4.17	0.822
47	Leaders in the ETE profession should make presentations at state and national mathematics and science conferences addressing the need for integration.	4.16	0.851
49	The ETE discipline should develop strategies for overcoming stereotypical perceptions often held by administrators, counselors, and secondary education faculty members.	4.16	0.868

Table 4.17

*Perceived Characteristics of CTAE Administrators in Priority Order by Mean Ratings (*N *= 69)* (*continued*)

Q	Statement	*M*	*SD*
46	ETE programs should continue to revise curriculum strategies to more accurately reflect mathematics and science concepts.	4.13	0.922
20	A broad range of assessment strategies (design portfolios, project work, performance testing) are used in ETE.	4.12	0.948
48	ETE professionals should conduct research to ascertain the integration needs of math and science teachers.	4.10	0.843
31	The ETE curriculum assists students in developing insight, understanding, and application of technological concepts, processes, and systems.	4.09	0.781
23	ETE has an organized set of concepts, processes, and systems.	4.06	0.938
26	ETE content is based on knowledge about the development of technology and its effect on people, the environment, and culture.	4.06	0.820
44	The ETE pathway reflects business and industry needs.	4.04	0.794
17	Verbal activity in the form of presentations and discussion of concepts and issues is emphasized in ETE.	4.03	0.954
43	The ETE pathway is guided by the technological literacy needs of the students.	4.03	0.766
28	A portion of the ETE instructional content is based on using resources to transfer information and communication.	3.96	0.652
29	A portion of the ETE instructional content is based on combining and modifying resources in standard stocks, goods, and structures (production).	3.88	0.832
18	Student cognitive strategies have clearly been developed.	3.87	1.010

Table 4.17

*Perceived Characteristics of CTAE Administrators in Priority Order by Mean Ratings (*N *= 69)* (*continued*)

Q	Statement	*M*	*SD*
25	ETE education content is based on an organized set of concepts, processes, and systems that are uniquely technological.	3.86	0.928
21	ETE lessons are hypothesis driven.	3.83	0.939
39	ETE should focus on the college-prep needs of students.	3.77	1.030
38	ETE should focus on the needs of special education students.	3.74	0.980
30	A portion of the ETE instructional content is based on the study of transportation systems.	3.70	0.845
27	A portion of the ETE instructional content is based on using biological organisms to modify products.	3.54	0.815
24	In ETE the modular method for program delivery should be dominant.	2.93	1.190

Note. Mean score based on 5-point scale: 1 (*strongly disagree*) to 5 (*strongly agree*).

Table 4.18
Perceived Characteristics of ETE Teachers in Priority Order by Mean Ratings

Q	Statement	*M*	*SD*
34	The ETE curriculum aids in the development of student problem-solving and decision-making skills.	4.72	0.500
13	ETE emphasizes problem solving.	4.71	0.668
36	Students enrolled in the ETE pathway use math and science skills to perform tasks.	4.67	0.473
37	The ETE teacher assists students to see the connection between scientific and math skills and its applications to engineering and technology.	4.66	0.476
16	Cooperative learning and small group instruction is encouraged in ETE.	4.65	0.596
35	ETE helps prepare students for lifelong learning in a technological society.	4.64	0.481
40	ETE provides an avenue for applying concepts learning in math and science.	4.64	0.497
20	A broad range of assessment strategies (design portfolios, project work, performance testing) are used in ETE.	4.63	0.650
32	The ETE curriculum allows for the application or tools, materials, machines, processes, and technical concepts.	4.63	0.501
14	ETE provides exploratory activities that include modeling, graphing, and production.	4.62	0.698
33	The ETE curriculum aids in the development of student skills, creative abilities, positive self-concepts, and individual potential in engineering and technology.	4.6	0.491
31	The ETE curriculum assists students in developing insight, understanding, and application of technological concepts, processes, and systems.	4.58	0.511
22	ETE provides activity-oriented laboratory instruction that reinforces abstract concepts with concrete examples.	4.56	0.611

Table 4.18

Perceived Characteristics of ETE Teachers in Priority Order by Mean Ratings (*continued*)

Q	Statement	*M*	*SD*
41	ETE should be available to all students who enroll in math and science.	4.53	0.674
49	The ETE discipline should develop strategies for overcoming stereotypical perceptions often held by administrators, counselors, and secondary education faculty members.	4.52	0.699
15	ETE instruction is goal oriented.	4.47	0.700
19	ETE emphasizes interdisciplinary activities.	4.43	0.758
42	ETE is an applied science.	4.41	0.725
17	Verbal activity in the form of presentations and discussion of concepts and issues is emphasized in ETE.	4.38	0.652
28	A portion of the ETE instructional content is based on using resources to transfer information and communication.	4.37	0.546
26	ETE content is based on knowledge about the development of technology and its effect on people, the environment, and culture.	4.36	0.694
23	ETE has an organized set of concepts, processes, and systems.	4.31	0.789
46	ETE programs should continue to revise curriculum strategies to more accurately reflect mathematics and science concepts.	4.29	0.698
29	A portion of the ETE instructional content is based on combining and modifying resources in standard stocks, goods, and structures (production).	4.22	0.615
47	Leaders in the ETE profession should make presentations at state and national mathematics and science conferences addressing the need for integration.	4.2	0.711

Table 4.18

Perceived Characteristics of ETE Teachers in Priority Order by Mean Ratings (*continued*)

Q	Statement	*M*	*SD*
25	ETE education content is based on an organized set of concepts, processes, and systems that are uniquely technological.	4.19	0.693
30	A portion of the ETE instructional content is based on the study of transportation systems.	4.19	0.750
44	The ETE pathway reflects business and industry needs.	4.19	0.670
43	The ETE pathway is guided by the technological literacy needs of the students.	4.16	0.808
45	ETE teachers should form interdisciplinary committees to develop integration strategies.	4.12	0.820
48	ETE professionals should conduct research to ascertain the integration needs of math and science teachers.	4.12	0.725
39	ETE should focus on the college-prep needs of students.	4.1	0.874
18	Student cognitive strategies have clearly been developed.	4.09	0.833
21	ETE lessons are hypothesis driven.	3.82	0.861
38	ETE should focus on the needs of special education students.	3.61	0.995
27	A portion of the ETE instructional content is based on using biological organisms to modify products.	3.43	0.998
24	In ETE the modular method for program delivery should be dominant.	2.64	1.190

Note. Mean score based on 5-point scale: 1 (*strongly disagree*) to 5 (*strongly agree*).

Analysis of Null Hypotheses

Null Hypothesis 1

H_o1: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES with regards to ETE teaching methodology.

Table 4.19 provides the mean scores for both the ETE teachers and CTAE administrators for Items 13–24 concerned with ETE teaching methods. Both groups had Item 13 ("ETE emphasizes problem solving") with the highest mean. Both groups had Item 24 ("ETE modular method should be the dominant form of delivery") with the lowest mean.

Table 4.20 exhibits the one-way ANOVA comparing perceptions of ETE teachers and CTAE administrators regarding ETE teaching methodology. There was a significant difference when comparing the perceptions with regard to ETE teaching methodology content at the level $p < 0.05$ ($F = 7.264$, $p = .01$). Therefore, H_o1 regarding ETE teaching methodology was rejected.

Table 4.19

Perceived Characteristics of ETE Teaching Methodology

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
13	Engineering and technology education emphasizes problem solving.	69	4.30	1.090	1–5	126	4.71	.668	1–5	10.61 (.001)
14	Engineering and technology education provide exploratory activities that include modeling, graphing, and production.	69	4.29	.972	1–5	129	4.62	.698	1–5	7.59 (.006)
15	Engineering and technology education instruction is goal oriented.	69	4.20	.994	1–5	127	4.47	.700	1–5	4.89 (.028)
16	Cooperative learning and small group instruction is encouraged in engineering and technology education.	69	4.30	.912	1–5	128	4.65	.596	1–5	10.17 (.002)
17	Verbal activity in the form of presentations and discussion of concepts and issues is emphasized in engineering and technology education.	69	4.03	.954	1–5	129	4.38	.652	1–5	9.32 (.003)
18	Student cognitive strategies have clearly been developed.	69	3.87	1.010	1–5	129	4.09	.833	2–5	2.77 (.098)
19	Engineering and technology education emphasizes interdisciplinary activities.	69	4.20	.867	1–5	129	4.43	.758	1–5	3.53 (.062)
20	A broad range of assessment strategies (design portfolios, project work, performance testing) are used in engineering and technology education.	69	4.12	.948	1–5	129	4.63	.650	1–5	20.05 (.001)

Table 4.19

Perceived Characteristics of ETE Teaching Methodology (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
21	Engineering and technology education lessons are hypothesis driven.	69	3.83	.939	1–5	129	3.82	.861	2–5	.001 (.974)
22	Engineering and technology education provides activity-oriented laboratory instruction that reinforces abstract concepts with concrete examples.	69	4.25	.914	1–5	129	4.56	.611	2–5	8.19 (.005)
23	Engineering and technology education has an organized set of concepts, processes, and systems.	69	4.06	.938	1–5	129	4.31	.789	1–5	4.02 (.046)
24	In engineering and technology education the modular method for program delivery should be dominant.	69	2.93	1.190	1–5	129	2.64	1.190	1–5	2.58 (.110)

Note. Mean score based on 5-point scale: 1 (*strongly disagree*) to 5 (*strongly agree*).

Table 4.20

Summary of ANOVA Comparing ETE Teachers and CTAE Administrators With ETE Teaching Methodology

	CTAE administrators				ETE high school teachers				
Subscale	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
Teaching methodology	73	4.18	.823	1–5	130	4.43	.505	1.27–5.00	7.264 (.01)

**Significant at $p < 0.05$.

Null Hypothesis 2

H_o2: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES regarding ETE curriculum content.

Table 4.21 provides the mean scores for both the ETE teachers and CTAE administrators for Items 25–39 concerned with ETE education content. Both groups differed on what was perceived as the most important aspect regarding ETE content. ETE teachers identified Item 34 ("The ETE curriculum aids in the development of student problem-solving and decision-making skills") with the highest mean, whereas the CTAE administrators identified Item 36 ("Students enrolled in the engineering and technology education pathway use math and science skills to perform tasks") with the highest mean.

Table 4.22 exhibits the one-way ANOVA comparing perceptions of ETE teachers and CTAE administrators regarding ETE education content. There was a significant difference when comparing the perceptions with regard to ETE curriculum content at the level $p < 0.05$ ($F = 26.10$, $p = .01$). Therefore, H_o2 regarding ETE education content was rejected.

Table 4.21

Perceived Characteristics of ETE Curriculum Content

Q	Statement	CTAE administrators				ETE high school teachers				F (p)
		n	*M*	*SD*	Range	*n*	*M*	*SD*	Range	
25	Engineering and technology education content is based on an organized set of concepts, processes, and systems that are uniquely technological.	69	3.86	.928	1–5	129	4.19	.693	2–5	8.04 (.005)
26	Engineering and technology education content is based on knowledge about the development of technology and its effect on people, the environment, and culture.	69	4.06	.820	1–5	129	4.36	.694	2–5	7.32 (.007)
27	A portion of the engineering and technology education instructional content is based on using biological organisms to modify products.	69	3.54	.815	1–5	129	3.43	.998	1–5	.616 (.434)
28	A portion of the engineering and technology education instructional content is based on using resources to transfer information and communication.	69	3.96	.652	1–5	129	4.37	.546	2–5	22.71 (.001)
29	A portion of the engineering and technology education instructional content is based on combining and modifying resources in standard stocks, goods, and structures (production).	69	3.88	.832	1–5	129	4.22	.615	2–5	10.71 (.001)
30	A portion of the engineering and technology education instructional content is based on the study of transportation systems.	69	3.70	.845	1–5	128	4.19	.750	1–5	17.61 (.001)

Table 4.21
Perceived Characteristics of ETE Curriculum Content (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
31	The engineering and technology education curriculum assists students in developing insight, understanding, and application of technological concepts, processes, and systems.	69	4.09	.781	1–5	129	4.58	.511	3–5	28.77 (.001)
32	The engineering and technology education curriculum allows for the application or tools, materials, machines, processes, and technical concepts.	69	4.26	.834	1–5	129	4.63	.501	3–5	14.94 (.001)
33	The engineering and technology education curriculum aids in the development of student skills, creative abilities, positive self-concepts, and individual potential in engineering and technology.	69	4.23	.825	1–5	129	4.60	.491	4–5	15.87 (.001)
34	The engineering and technology education curriculum aids in the development of student problem-solving and decision-making skills.	69	4.30	.845	1–5	129	4.72	.500	2–5	18.98 (.001)
35	Engineering and technology education helps prepare students for lifelong learning in a technological society.	69	4.19	.772	1–5	129	4.64	.481	4–5	26.01 (.001)
36	Students enrolled in the engineering and technology education pathway use math and science skills to perform tasks.	69	4.39	.826	1–5	129	4.67	.473	4–5	8.90 (.003)

Table 4.21

Perceived Characteristics of ETE Curriculum Content (*continued*)

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
37	The engineering and technology education teacher assists students to see the connection between scientific and math skills and its applications to engineering and technology.	69	4.30	.828	1–5	129	4.66	.476	4–5	14.65 (.001)
38	Engineering and technology education should focus on the needs of special education students.	69	3.74	.980	1–5	129	3.61	.995	1–5	.737 (.392)
39	Engineering and technology education should focus on the college-prep needs of students.	69	3.77	1.030	1–5	129	4.10	.874	1–5	5.74 (.018)

Note. Mean score based on 5-point scale: 1 (*strongly disagree*) to 5 (*strongly agree*).

Table 4.22

Summary of ANOVA Comparing ETE Teachers and CTAE Administrators With ETE Curriculum Content

	CTAE administrators				ETE high school teachers				
Subscale	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
Curriculum content	69	4.10	.684	1–5	130	4.49	.37	3.42–5.00	26.10 (.01)

**Significant at $p < 0.05$.

Null Hypothesis 3

H_o3: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES regarding the integration of STEM in the ETE high school pathway.

Table 4.23 provides the mean scores for both the ETE teachers and CTAE administrators for Items 40–44 concerned with STEM integration in the ETE high school pathway. Both groups differed on what was perceived as the most important aspect regarding STEM integration in the ETE high school pathway. ETE teachers identified Item 40 (“Engineering and technology education provides an avenue for applying concepts learning in math and science”) with the highest mean, whereas the CTAE administrators identified Item 42 (“Engineering and technology education is an applied science”) with the highest mean.

Table 4.24 exhibits the one-way ANOVA comparing perceptions of ETE teachers and CTAE administrators regarding STEM integration in the ETE high school pathway. There was a significant difference when comparing the perceptions with regard to STEM integration in the ETE high school pathway at the level $p < 0.05$ ($F = 6.49$, $p = .01$). Therefore, H_o3 regarding STEM integration in the ETE high school pathway was rejected.

Table 4.23

Perceived Characteristics of STEM Integration in the ETE High School Pathway

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
40	Engineering and technology education provides an avenue for applying concepts learning in math and science.	69	4.33	.816	1–5	129	4.64	.497	3–5	11.01 (.001)
41	Engineering and technology education should be available to all students who enroll in math and science.	69	4.25	.847	1–5	129	4.53	.674	2–5	6.86 (.010)
42	Engineering and technology education is an applied science.	69	4.49	.896	1–5	129	4.41	.725	1–5	3.58 (.060)
43	The engineering and technology education pathway is guided by the technological literacy needs of the students.	69	4.03	.766	1–5	129	4.16	.808	2–5	1.28 (.260)
44	The engineering and technology education pathway reflects business and industry needs.	69	4.04	.794	1–5	129	4.19	.670	2–5	1.78 (.183)

Note. Mean score based on 5-point scale: 1 (*strongly disagree*) to 5 (*strongly agree*).

Table 4.24

Summary of ANOVA Comparing ETE Teachers and CTAE Administrators With STEM Integration in the ETE High School Pathway

Subscale	CTAE administrators				ETE high school teachers				
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
STEM integration	69	4.17	.731	1–5	129	4.39	.477	3.20–5.00	6.49 (.01)

**Significant at $p < 0.05$.

Null Hypothesis 4

H_o4: There is no significant difference between the perception of Georgia ETE pathway high school teachers and CTAE administrators as measured by the CETES regarding how to improve the ETE high school pathway.

Table 4.25 provides the mean scores for both the ETE teachers and CTAE administrators for Items 45–49 concerned with how to improve the ETE high school pathway. Both groups differed on what was perceived as the most important aspect regarding how to improve the ETE high school pathway. ETE teachers identified Item 49 ("The engineering and technology education discipline should develop strategies for overcoming stereotypical perceptions often held by administrators, counselors, and secondary education faculty members") with the highest mean, whereas the CTAE administrators identified Item 45 ("Engineering and technology education teachers should form interdisciplinary committees to develop integration strategies") with the highest mean.

Table 4.26 exhibits the one–way ANOVA comparing perceptions of ETE teachers and CTAE administrators regarding how to improve the ETE high school pathway. There was not a significant difference when comparing the perceptions with regard to how to improve the ETE high school pathway at the level $p < 0.05$ ($F = 1.21$, $p = .27$). Therefore, H_o4 regarding how to improve the ETE high school pathway was retained.

Table 4.25
Perceived Characteristics of How to Improve the ETE High School Pathway

		CTAE administrators				ETE high school teachers				
Q	Statement	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
45	Engineering and technology education teachers should form interdisciplinary committees to develop integration strategies.	69	4.17	.822	1–5	129	4.12	.820	2–5	.166 (.684)
46	Engineering and technology education programs should continue to revise curriculum strategies to more accurately reflect mathematics and science concepts.	69	4.13	.922	1–5	129	4.29	.698	1–5	1.79 (.182)
47	Leaders in the engineering and technology education profession should make presentations at state and national mathematics and science conferences addressing the need for integration.	69	4.16	.851	1–5	129	4.20	.711	2–5	.137 (.712)
48	Engineering and technology education professionals should conduct research to ascertain the integration needs of math and science teachers.	69	4.10	.843	1–5	129	4.12	.725	2–5	.017 (.897)
49	The engineering and technology education discipline should develop strategies for overcoming stereotypical perceptions often held by administrators, counselors, and secondary education faculty members.	69	4.16	.868	1–5	128	4.52	.699	2–5	9.80 (.002)

Note. Mean score based on 5-point scale: 1 (*strongly disagree*) to 5 (*strongly agree*).

Table 4.26

Summary of ANOVA Comparing ETE Teachers and CTAE Administrators With How to Improve the ETE High School Pathway

	CTAE administrators				ETE high school teachers				
Subscale	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*F* (*p*)
Improve ETE	69	4.14	.769	1–5	129	4.25	.555	2.80–5.00	1.21 (.27)

**Significant at $p < 0.05$.

Summary

Chapter 4 presented the results of the CETES. The researcher analyzed data to provide answers to the research questions in determining the perceptions of Georgia ETE high school pathway teachers and CTAE administrators regarding Georgia's STEM Career Cluster ETE high school pathway as it relates to teaching methodology, curriculum content, STEM integration, and how to improve the pathway. Three of the four null hypotheses were not retained as they met the significance criteria of $p < 0.05$.

Further discussion about major findings, conclusions from the research findings, implications of the study for the field of STEM and ETE, and recommendations are presented in Chapter 5.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

Introduction

This chapter provides a summary of the study, research findings, and conclusions drawn by the researcher about the perceptions held by two of the main stakeholders (ETE high school teachers and CTAE administrators) in the Georgia school system regarding the STEM Career Cluster ETE high school pathway.

Summary

Research has shown that there is a lack of information available to CTAE leaders in Georgia regarding the perceptions of Georgia STEM Career Cluster ETE high school teachers and CTAE administrators toward CTAE programs. This study was concerned with determining the perceptions of Georgia STEM Career Cluster ETE high school teachers and CTAE administrators regarding the ETE high school pathway and its effect on implementation within their district and schools.

This study answered the following four questions, which were based on previous studies conducted by Daugherty and Wicklein (Daugherty, 1993) and Daugherty et al. (1996):

1. Is there a significant difference in the perception of ETE teaching methodology between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?

2. Is there a significant difference in the perception of ETE curriculum content between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
3. Is there a significant difference in the perception of STEM integration in the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?
4. Is there a significant difference in the perception of how to improve the ETE high school pathway between Georgia ETE high school teachers and CTAE administrators as measured by the Characteristics of Engineering and Technology Education Survey?

The CTES was originally created by Daugherty and Wicklein (Daugherty, 1991) and was modified, with permission, to match the needs of the present study conducted in Georgia. The survey was renamed the CETES, aligning to Georgia's STEM Career Cluster ETE high school pathway. A 52-item online questionnaire was used to gather and summarize data in order to retain or reject the study hypotheses by examining the perceptions of Georgia STEM Career Cluster ETE high school teachers and CTAE administrators regarding teaching methodology, curriculum content, STEM integration in ETE, and how to improve the ETE high school pathway. A total of 243 surveys were returned, for a response rate of 59.5%. A one-way ANOVA was used to test the four hypotheses with a p value established at the < 0.05 level of significance for this study.

<u>Research Findings</u>

The data in this quantitative study were gathered from survey responses to determine if there was a significant difference between the perceptions of Georgia's STEM Career Cluster ETE high school pathway teachers and CTAE administrators as related to ETE teaching methodology, curriculum content, STEM integration, and how to improve the ETE pathway. After surveying 243 Georgia STEM Career Cluster ETE high school pathway teachers and CTAE administrators, collecting and analyzing the responses provided to the 52-item online CETES questionnaire, the study revealed significant differences in the perceptions regarding ETE teaching methodology, curriculum content, and STEM integration in relation to the STEM Career Cluster ETE high school pathway. H_o1- H_o3 was rejected. However, H_o4 was retained as there was no significant difference in the perceptions of the ETE high school teachers and CTAE administrators regarding how to improve the ETE high school pathway. Synthesis of the results in Chapter 4 produced the following conclusions:

1. There was a significant difference when comparing the perceptions with regard to ETE teaching methodology content at the level $p < 0.05$ ($F = 7.264$, $p = .01$). Therefore, H_o1 regarding ETE teaching methodology was not retained.
2. There was a significant difference when comparing the perceptions with regard to ETE curriculum content at the level $p < 0.05$ ($F = 26.10$, $p = .01$). Therefore, H_o2 regarding ETE education content was not retained.

3. There was a significant difference when comparing the perceptions with regard to STEM integration in the ETE high school pathway at the level $p < 0.05$ ($F = 6.49$, $p = .01$). Therefore, H_o3 regarding STEM integration in the ETE high school pathway was not retained.
4. There was not a significant difference when comparing the perceptions with regard to how to improve the ETE high school pathway at the level $p < 0.05$ ($F = 1.21$, $p = .27$). Therefore, H_o4 regarding how to improve the ETE high school pathway was retained.

Conclusions

Within the boundaries, limitations, and assumptions of this study and with the limits that the data and findings are reliable and valid, the following conclusions were drawn:

1. H_o1– H_o3 were rejected because ETE high school teachers and CTAE administrators showed differences in how the Georgia STEM Career Cluster ETE pathway is viewed in the areas of teaching methodology, curriculum content, and STEM integration.
2. H_o4 was retained because ETE high school teachers and CTAE administrators showed no differences in how the Georgia STEM Career Cluster ETE pathway needs to show improvement.

As part of Georgia's CTAE program of study, the STEM Career Cluster ETE high school pathway provides an essential part of a student's learning to over 18,800 high school students in Georgia (Georgia Department of Education, 2014a). Technology and engineering education continues to evolve as it becomes more apparent that students need this information to become more successful in college and their careers (Custer & Wright, 2009; Ritz & Moye, 2011). Not only does STEM education connect meaning to the academic focus of STEM as would normally be experienced in high school, but it also allows for the exploration in STEM occupational areas. These two factors add challenge and personal relevance to the entire learning process. Beltram (2010) stated:

> Career technology courses give students the "a-ha" moments that connect their learning to life. This leads not only to success in high school but also to preparation for what lies ahead in the real world where these students may be designing, producing, selecting, using, and assessing technology with concern for the environment, individuals, and society as a whole. (p. 11)

Clarifying the teaching methodology employed in the ETE classroom, identifying and cross-walking curriculum content to the newly revised ETE course standards, and creating a uniform plan on how to integrate the E into the STEM initiative in Georgia would help to alleviate the differing perceptions regarding the STEM Career Cluster ETE high school pathway by both primary stakeholders: Georgia STEM Career Cluster ETE high school pathway teachers and CTAE administrators. Doing so will thereby ensure not only the continuance of a program that has provided for the needs of all students since major changes in CTE happened in the late 1880s but also the innovative growth the ETE program will experience in the future with the value placed on integrative STEM education.

The results of the survey demonstrated that as an educational leader, the Georgia State Department of Education must be involved in discussions with key stakeholders about the establishment of a core ETE curriculum that not only aligns to the STEM Career Cluster ETE pathway of study but also insists on providing a rigorous and quality STEM program of instruction. Although the EbD curriculum is offered to teachers, as Georgia is a consortium state, it is not widely accepted or used among the teachers. A more aggressive marketing campaign needs to be developed that focuses on not only the ETE teacher but also the CTAE administrator. In addition, model lesson plans and resources that are directly correlated to the STL and ETE pathway course standards need to be developed. A professional learning plan needs to be created that addresses how teaching to the standards can be accomplished while focusing on not only the strengths of ETE teachers but also their academic areas of weakness. In doing so, a policy might be established and/or encouraged that requires continual collaboration between CTAE teachers and those of academics.

To this day, many differing opinions and perceptions exist about what ETE is, what should be taught, and where. There is resistance or failure on the part of CTAE administrators, teachers, and counselors because they do not fully know or understand the role ETE has in the total school environment. It is imperative that stakeholder perceptions of ETE in U.S. schools change both internally and externally. As the STEM movement continues to move forward at a rapid pace, it is imperative that the “T” and “E” components be represented and realized so that students may reach their full potential in applying the knowledge gained and creating and adapting in the social context of the ever-changing technological world.

It is crucial for ETE professionals to conduct continued research in the field, creating strategic plans that address three distinct questions: Where are we going? What will the future educational environment look like for ETE? and How do we get there? Results of this study added to the current knowledge base of perceptions of Georgia's STEM Career Cluster ETE high school teachers and CTAE administrators regarding the ETE high school pathway. The results will inform members of the Georgia Department of Education, CTAE stakeholders within Georgia school districts, and researchers and practitioners in the field of ETE about current understandings and opinions with respect to ETE in Georgia high schools. Using the data gathered in this study regarding the perceptions about selected characteristics of the ETE high school pathway by the two major stakeholders—STEM Career Cluster ETE high school pathway teachers and CTAE administrators—the Georgia Department of Education and CTAE Department will be able to make reasonable efforts in projecting the STEM Career Cluster ETE program forward in K–12 education throughout Georgia.

Recommendations for Further Research

In light of the review of related literature, findings, and conclusions, the following recommendations and questions for further research are offered:

1. With the changes being made regarding the focus of STEM in the overall landscape of K–12 education, what will the next survey instrument used to collect data from the two major stakeholders in ETE regarding their

perceptions and attitudes look like? Based on this study, it is apparent that the original CTES questionnaire is outdated and that a new instrument to measure perceptions and attitudes needs to be developed.

2. Further research needs to be conducted to determine what differences, if any, are occurring in the ETE program of study being taught between the PLTW teachers and EbD teachers based on student outcomes of ETE End of Pathway assessments.
3. Further research needs to be conducted on the value of the middle school ETE programs held by Georgia's ETE middle school teachers and CTAE administrators. The results of such a study could have important implications for both policy and practice of ETE programs of study in the K–12 education system in Georgia.
4. This study could be replicated with other pathways within the Manufacturing and Energy Career Clusters in Georgia to determine the knowledge, views, and attitudes of all teachers and administrators with regard to these programs. The results of such a study could have important implications for both policy and practice of career cluster programs of study in the K–12 education system in Georgia.
5. Study replication in another state is recommended. Results from another state or two to determine the knowledge and perceptions of ETE teachers and CTE administrators would be compared to this study to determine if the findings were generalizable across states. The results of this comparison could have

important implications for both policy and practice of engineering and technology programs in the K–12 education system across the United States.

APPENDICES

Appendix A

Institutional Review Board Approval

Nalinee Patin < NPATIN@clemson.edu> Mon, Jun 10, 2013 at 2:31 PM
To: Thomas Dobbins <TDBBNS@clemson.edu>
Cc: Dale Layfield <DLAYFIE@clemson.edu>, “fravel@clemson.edu” <fravel@clemson.edu>, “mvcrenshaw64@gmail.com” <mvcrenshaw64@gmail.com>

Dear Dr. Dobbins,

The chair of the Clemson University Institutional Review Board (IRB) validated the protocol identified above using exempt review procedures and a determination was made on June 10, 2013 that the proposed activities involving human participants qualify as Exempt under category B2, based on federal regulations 45 CFR 46. Your protocol will expire on November 30, 2013.

As of June 1, 2013, the Office of Research Compliance (ORC) started assign expiration dates to all IRB exempt protocols. The expiration date indicated above was based on the completion date you entered on the IRB application. If an extension is necessary, the PI should submit an Exempt Protocol Extension Request form, http://www.clemson.edu/research/compliance/irb/forms.html, at least three weeks before the expiration date. Please refer to our website for more information on the new procedures, http://www.clemson.edu/research/compliance/irb/guidance/reviewprocess.html.

No change in this approved research protocol can be initiated without the IRB’s approval. This includes any proposed revisions or amendments to the protocol or consent form. Any unanticipated problems involving risk to subjects, any complications, and/or any adverse events must be reported to the Office of Research Compliance (ORC) immediately. All team members are required to review the “Responsibilities of Principal Investigators” and the “Responsibilities of Research Team Members” available at http://www.clemson.edu/research/compliance/irb/regulations.html.

The Clemson University IRB is committed to facilitating ethical research and protecting the rights of human subjects. Please contact us if you have any questions and use the IRB number and title in all communications regarding this study.

Good luck with your study.

All the best,
Nalinee
Nalinee D. Patin
IRB Coordinator
Clemson University
Office of Research Compliance
Institutional Review Board (IRB)
Website: http://www.clemson.edu/research/compliance/irb/ IRB
E-mail: irb@clemson.edu

Appendix B

Survey E-Mail Cover Letter

Dear High School Engineering and Technology Teacher and CTAE Administrator:

My name is Mark Crenshaw; I am the CTAE Program Specialist for STEM Engineering and Technology Education at the Georgia Department of Education and a Doctoral student at Clemson University. As part of the requirements to complete the Ed.D. degree in Career and Technology Education, I am studying the perceptions of CTAE administrators and high school Engineering and Technology education pathway teachers in Georgia regarding the STEM Engineering and Technology education pathway.

This letter is to request your assistance in gathering data to analyze for this study. Your participation is strictly voluntary. If you choose to participate it will be greatly appreciated and assist in improving the quality of my findings. Please complete the questionnaire attached to the survey link below. The survey includes 12 demographic questions and 40 content questions designed to collect your perception of the Engineering and Technology education pathway. I estimate no more than 10 minutes of your time is necessary to answer the questions completely and honestly. Completion of the survey will indicate your providing permission to use the data for my study. Please be assured that you responses will remain confidential and a copy of the study's results will be available upon request.

Your immediate response to the survey allows for a quicker time to tabulate the results. I want to extend my sincere appreciation in advance for your assistance in completing the survey in a timely manner and assisting me to address the needs of not only my program area but also your school and/or district regarding the implementation and support of the Engineering and Technology education pathway.

If you have any questions about this research study, please call me at (404) 657-8316 or (706) 455-9266. You may also email me at mcrenshaw@doe.k12.ga.us. You may also contact Dr. Bill Paige, Doctoral Committee Co-chair at Clemson University. His email is wpaige@clemson.edu if you need further assistance. If you have concerns about the treatment of research participants, you can contact the Clemson Office of Research, Institutional Review Board (IRB) on the Use of Human Research Subjects at Clemson University, 223 Brackett Hall, Box 345704, Clemson, SC 29634. The phone number is (866) 297-3071. The website for the office of research compliance is www.clemson.edu/research/compliance. Thank you again for your consideration of my request.

Respectfully,
Mark V. Crenshaw
Mark Crenshaw

Appendix C

Survey Reminder E-Mail

Re: Dissertation Information request regarding the CTAE STEM Cluster Engineering and Technology Pathway

Dear High School Engineering and Technology Teacher and CTAE Administrator:

My name is Mark Crenshaw; I am the CTAE Program Specialist for STEM Engineering and Technology Education at the Georgia Department of Education and a Doctoral student at Clemson University. As part of the requirements to finish the Ed.D. degree in Career and Technology Education, I am studying the perceptions of CTAE administrators and high school Engineering and Technology education teachers in Georgia towards the STEM Engineering and Technology education pathway.

The other day I sent a similar letter along with a survey link requesting your voluntary assistance in gathering perceptional data towards Georgia's STEM Career Cluster Engineering and Technology Education pathways that will aide in completing my dissertation. This letter is a follow-up request in seeking your assistance to be able to gather the data needed to analyze for this study. Your participation is strictly voluntary and you will not be punished in any way if you decide not to be in the study or if you choose to stop taking part in the study. If you choose to participate it will be greatly appreciated and assist in improving the quality of my findings. Please complete the questionnaire attached to the survey link below. The survey includes 12 demographic questions and 40 content questions designed to collect your perception of the Engineering and Technology education pathway. I estimate no more than 10 minutes of your time is necessary to answer the questions completely and honestly. Completion of the survey will indicate your providing permission to use the data for my study. Please be assured that you responses will remain confidential and a copy of the study's results will be available upon request.

Your immediate response to the survey allows for a quicker time to tabulate the results. I want to extend my sincere appreciation in advance for your assistance in completing the survey in a timely manner and assisting me to address the needs of not only my program area but also your school and/or district regarding the implementation and support of the Engineering and Technology education pathway.

If you have any questions about this research study, please call me at (404) 657-8316 or (706) 455-9266. You may also email me at mcrenshaw@doe.k12.ga.us. You may also contact Dr. Bill Paige, Doctoral Committee Co-chair at Clemson University. His email is wpaige@clemson.edu if you need further assistance. Thank you again for your consideration of my request.

Respectfully,
Mark V. Crenshaw

Appendix D

Permission to Use the Characteristics of Technology Education Survey

From: Michael Daugherty
To: Mark Crenshaw
Cc: wpaige@clemson.edu
Subject: RE: Characteristics of Technology Education Survey (CTES) use permission?
Date: Monday, May 06, 2013 10:12:36 AM

Mark,

You have my permission to both use the survey and adapt it to more directly relate to STEM. Please share your results with me and good luck with your dissertation.

Best Regards, Mike
Michael K. Daugherty
Professor of Technology Education
Department Head - Curriculum and Instruction College of Education and Health Professions University of Arkansas
217 Peabody Hall Fayetteville AR 72701 (479) 575-4209 (O) (479) 575-6676 (F)
This email, including any attachments, is for the sole use of the intended recipients and may contain confidential and privileged information. Any unauthorized review, use, disclosure, or redistribution is prohibited. If you are not the intended recipient, please contact the sender and delete the original message.

From: Mark Crenshaw [mailto:MCrenshaw@doe.k12.ga.us]
Sent: Saturday, May 04, 2013 2:28 PM
To: Michael Daugherty
Cc: wpaige@clemson.edu
Subject: Characteristics of Technology Education Survey (CTES) use permission?
Importance: High

Dr. Daugherty,

I am a current doctoral student at Clemson University with Dr. Bill Paige as my committee chair. To assist in my current position as Program Specialist for Engineering and Technology Education at the Georgia Department of Education I am researching the attitudes and perceptions of Engineering and Technology Education high school teachers and district Career and Technology Education administrators towards the Engineering and Technology (E&T) education programs that are included in our STEM Career Cluster in Georgia. It is my intent to use the information gathered to create a statewide plan of action to increase the rigor and relevance of the program, provide support to existing programs, create growth for new programs around the state, to educate and provide assistance to CTE district administrators regarding the E&T programs, and to assist the University System of Georgia in establishing or re-establishing an undergraduate E&T teacher preparation program. I have researched the validated CTES survey you used in your own doctoral study from 1991 along with additional uses in articles and dissertations directly related to Technology Education. An example of the application of the survey would be found in: Hill, R.B., Wicklein, R.C., & Daugherty, M.K. (1996). Technology education in transition: Perceptions of technology education teachers, administrators, and guidance counselors. Journal of Industrial Teacher Education, 33 (3), 6-23. The most current use I have researched can be found in Dr. Steven Rogers's dissertation from 2012 titled Perceptions of Indiana's Engineering/Technology Education classroom teachers as measured by the CTES.

With this being said, I would like your permission to use the “Characteristics of Technology Education Survey” (CTES). I believe this to be a good instrument to measure both the teachers and administrator’s attitudes and perceptions of our E&T programs around the state. I would also like to ask your permission to include the word “STEM,” “Career Cluster,” and “Engineering and Technology Education” in my revision that will also include additional questions directly related to the direct duties and responsibilities of CTE administrator’s as it relates to CTE programs.

Please let me know if you have any questions or additional thoughts as it relates to this request. In addition, if you have any additional resources that would align to the proposed study I would be happy to hear about them. Thank you for your consideration and assistance of my request.

Regards,
Mark V. Crenshaw
Mark Crenshaw
Program Specialist, Engineering and Technology
GATSA State Advisor
Career, Technical and Agricultural Education
Georgia Department of Education
205 Jesse Hill Jr. Drive, SE
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Like us on Facebook: http://www.facebook.com/gadoe
“Making Education Work for All Georgians”

Appendix E

Survey Instrument

Characteristics of the STEM Career Cluster Engineering and Technology

1. Part I Demographics

The following section is used to determine demographics and will be considered confidential. Please answer the following questions by choosing the appropriate answer/response to each statement.

1. Which of the following best describes your job function?
Choose an item.

Other (please specify)
Click here to enter text.

2. Is the STEM Career Cluster–Engineering and Technology education pathway offered in your school or district?

☐ Yes
☐ No

2. Demographics Part II

Please answer the following questions by choosing the appropriate answer/response to each statement.

3. If an Engineering and Technology education educator indicate the predominant pathway of instruction.

☐ Engineering and Technology
☐ Engineering Drafting and Design
☐ Electronics
☐ Manufacturing
☐ Energy
☐ N/A – Administrator/Counselor

4. Are you certified in any Project Lead the Way preengineering courses?

☐ Yes
☐ No
☐ N/A – Administrator/Counselor

5. Do you use the ITEEA's Engineering by Design curriculum?

☐ Yes
☐ No
☐ N/A – Administrator/Counselor

6. Is the Engineering and Technology education program industry certified?

☐ Yes
☐ No

7. Indicate the total number of years you have been in your current position?

☐ 1–3
☐ 4–8
☐ 9–15
☐ Over 15

8. Indicate the total number of years you have been employed in the education field.

☐ 1–3
☐ 4–8
☐ 9–15
☐ Over 15

9. In what type of community is your school currently located?

☐ City or urban community
☐ Suburban community
☐ Rural community

10. What is the highest level of school you have completed or the highest degree you have received?

☐ Less than high school degree
☐ High school degree or equivalent (e.g., GED)
☐ Some college but no degree
☐ Associate's degree
☐ Bachelor's degree
☐ Graduate degree

11. Which of the following best describes the field in which you received your highest degree?

☐ Mathematics
☐ Science
☐ Health care
☐ Medicine
☐ Computing
☐ Engineering
☐ Technology
☐ Business
☐ Technology Education
☐ Industrial Arts
☐ Vocational Education
☐ Administration
☐ Counseling
☐ Other (please specify)

12. Which category below includes your age?

☐ 17 or younger
☐ 18–20
☐ 21–29
☐ 30–39
☐ 40–49
☐ 50–59
☐ 60 or older

3. Part II: Teaching Methods

The following questions relate to your perception of the teaching methods used in the Engineering and Technology education pathway.

Please indicate by selecting from one of the following:

1. Strongly Disagree
(conflicts radically with my perception)

2. Disagree
(statement is inconsistent with my perception)

3. No Opinion
(no perception at this time)

4. Agree
(statement agrees with my perception)

5. Strongly Agree
(exemplifies my perception)

13. Engineering and Technology education emphasizes problem solving.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

14. Engineering and Technology education provides exploratory activities that include modeling, graphing, and production.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

15. Engineering and Technology education instruction is goal oriented.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

16. Cooperative learning and small group instruction is encouraged in Engineering and Technology education.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

17. Verbal activity in the form of presentations and discussions of concepts and issues is emphasized in Engineering and Technology education.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. Student cognitive strategies have clearly been developed.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

19. Engineering and Technology education emphasizes interdisciplinary activities.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

20. A broad range of assessment strategies (design portfolios, project work, performance testing) are used in Engineering and Technology education.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

21. Engineering and Technology education lessons are hypothesis driven.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

22. Engineering and Technology education provides activity-oriented laboratory instruction that reinforces abstract concepts with concrete experiences.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

23. Engineering and Technology education has an organized set of concepts, processes, and systems.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

24. In Engineering and Technology education the modular method for program delivery should be dominant.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

4. Part III: Engineering and Technology Education Content

The following questions relate to your perception of the content characteristics in Engineering and Technology education.

25. Engineering and Technology education content is based on an organized set of concepts, processes, and systems that are uniquely technological.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

26. Engineering and Technology education content is based on knowledge about the development of technology and its effect on people, the environment, and culture.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

27. A portion of the Engineering and Technology education instructional content is based on using biological organisms to make or modify products.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

28. A portion of the Engineering and Technology education instructional content is based on using resources to transfer information and communication.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

29. A portion of the Engineering and Technology education instructional content is based on combining and modifying resources in standard stocks, goods, and structures (production).

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

30. A portion of the Engineering and Technology education instructional content is based on the study of transportation systems.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

31. The Engineering and Technology education curriculum assists students in developing insight, understanding, and application of technological concepts, processes, and systems.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

32. The Engineering and Technology education curriculum allows for the application of tools, materials, machines, processes, and technical concepts.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

33. The Engineering and Technology education curriculum aids in the development of student skills, creative abilities, positive self-concepts, and individual potential in engineering and technology.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

34. The Engineering and Technology education curriculum aids in the development of student problem-solving and decision-making skills.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

35. Engineering and Technology education helps prepare students for lifelong learning in a technological society.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

36. Students enrolled in the Engineering and Technology education pathway use math and science skills to perform tasks.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

37. The Engineering and Technology education teacher assists students to see the connection between scientific and math skills and its applications to engineering and technology.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

38. Engineering and Technology education should focus on the needs of special education students.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

39. Engineering and Technology education should focus on the college-prep needs of students.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

5. Part IV: Integration of STEM

The following questions relate to your perception of the need to integrate Math, Science, and Engineering and Technology education.

40. Engineering and Technology education provides an avenue for applying concepts learned in math and science.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

41. Engineering and Technology education should be available to all students who enroll in math and science.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

42. Engineering and Technology education is an applied science.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

43. The Engineering and Technology education pathway is guided by the technological literacy needs of the students.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

44. The Engineering and Technology education pathway reflects business and industry needs.

Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree ☐

6. Part V: How to Improve Engineering and Technology Education

The following questions relate to actions that the STEM Engineering and Technology education profession can take to improve perceptions of the field.

45. Engineering and Technology education teachers should form interdisciplinary committees to develop integration strategies.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

46. Engineering and Technology education programs should continue to revise curriculum strategies to more accurately reflect mathematics and science concepts.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

47. Leaders in the Engineering and Technology education profession should make presentations at state and national mathematics and science conferences addressing the need for integration.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

48. Engineering and Technology education professionals should conduct research to ascertain the integration needs of math and science teachers.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

49. The Engineering and Technology education discipline should develop strategies for overcoming stereotypical perceptions often held by administrators, counselors, and secondary education faculty members.

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
☐	☐	☐	☐	☐

50. The goal of this study is to improve the STEM Engineering and Technology education pathway in Georgia. To address this goal, what are some limitations for successful implementation of the Engineering and Technology pathway in Georgia?

51. What are some of the strengths of the STEM Engineering and Technology pathway in Georgia?

52. Please explain your perception of the importance of the STEM Engineering and Technology education pathway in the overall school curriculum.

REFERENCES

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