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Comparing High School Students' and Adults' Perceptions of Technological Literacy

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COMPARING HIGH SCHOOL STUDENTS' AND ADULTS' PERCEPTIONS OF TECHNOLOGICAL LITERACY

by

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ABSTRACT

COMPARING HIGH SCHOOL STUDENTS' AND ADULTS' PERCEPTIONS OF TECHNOLOGICAL LITERACY

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This study compared high school student's perceptions of technology and technological literacy to those perceptions of the general public. Additionally, individual student groups were compared statistically to determine significant differences between the groups. The *ITEA/Gallup Poll* instrument was used to survey high school student's perceptions of technology in the study. The instrument has been used twice (2001, 2004) in the United States and once (2005) in Hong Kong to survey adult's perceptions of technology. The student population in question consisted of three subgroups: students enrolled in a standards-based technology education courses, students enrolled in a Project Lead the Way® (PLTW®) *Principles of Engineering* pre-engineering course, and students enrolled in a general education course (language arts, mathematics, or science). In addition, each student group's perceptions of technology were compared to one another to determine differences within each group.

A convenience sample (n=10) was drawn from the entire population of North Carolina's *Fundamentals of Technology* course teachers (N=125) and a sample (n=9) was drawn from the entire population of North Carolina's PLTW® (N=35) programs. Additionally, a convenience sample consistent with the number of *Fundamentals of Technology* courses and PLTW® courses was drawn for the study to serve in a reference group capacity. Since the entire population of North Carolina's PLTW® programs was

(N=35), only nine schools from each of the three groups were mailed the survey packet. Randomly selected teachers were mailed a cover letter explaining the study to the teachers, parent consent form, student participation form, a reference copy of the survey including specific demographic information, and the *ITEA/Gallup Poll* (2001/2004). Data collected were compared using chi-square analysis to answer the research questions.

Of the 29 packets mailed out to teachers of all three different groups, 15 packets were returned for a response rate of 51.7%. A total of 151 students were surveyed, 58 of which were enrolled in technology education classes, 23 in PLTW® classes, and 70 enrolled in general education classes. All instruments were deemed usable for the study.

Thirteen of the 66 items in the *ITEA/Gallup Poll* (2001/2004) showed a significant difference between students that complete a Project Lead the Way® pre-engineering course, students who complete the *Fundamentals of Technology* standards-based technology education course, and students who are only enrolled in general education courses. Of those 13 items showing a significant difference between all three groups, 7 of the 13 items showed a significant difference between technology education and PLTW® respondents, 6 of the 13 items showed a significant difference between PLTW® and general education respondents, and 8 of the 13 items showed a significant difference between technology education and general education group respondents.

Co-Directors of Advisory Committee: Dr. William C. Bridges
Dr. John M. Ritz

This dissertation is dedicated to my mom, Peggy Harrison for always pushing me and helping me strive to succeed in all that I do. I also thank my dad, Laddie Harrison for giving me the support and opportunities to fulfill my dreams. I love you both.

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CHAPTER I

INTRODUCTION

High school pre-engineering programs are among the fastest growing new education courses in the United States (Cech, 2007). Lewis (2004) defined pre-engineering as "… coursework or subjects that draw content from the work of engineers, and that promise engineering careers as likely futures of the students who pursue them" (p. 22). A variety of pre-engineering courses are coming online and being introduced into schools around the nation (McVeary, 2003). Perhaps the most popular pre-engineering program being incorporated in schools across the United States is Project Lead the Way® (PLTW®) (Hughes, 2006; Ereckson & Custer, 2008). PLTW® was conceived and developed in upstate New York in the mid-1990s and funded by an educational endowment. The founding premise was to prepare a curriculum designed to encourage students to become interested in the engineering field and ultimately increase the numbers of engineers and engineering technicians in the United States (Hughes, 2006, p. 35). The Division of National Labor Statistics noted the rising need for future engineers as well as the current critical shortage of qualified engineers in the profession (Southern Regional Education Board, 2001). Theoretically, the idea of developing pre-engineering programs to combat these critical issues is just natural; however other programs, such as technology education, are beginning to suffer from the recent growth of pre-engineering programs around the nation (Rogers, 2006; Daugherty, personal communication, August 5, 2008). PLTW® and other similar pre-engineering programs in many states are starting to change technology education programs in both middle and high schools around the nation, although they are not defined as a technology education program (Blais & Adelson, 1998).

Technology education programs have for years served the United States by teaching students about technological processes that are needed to solve problems and extend human capability (ITEA, 2000/2002). Technology is defined as "human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capability" (ITEA, 2000/2002, p. 242). In recent years, the push for standards and refinement gave reason for a clearer definition of technology and technological literacy and what makes a person technologically literate. The International Technology Education Association (ITEA) published *Standards for Technological Literacy: Content for the Study of Technology* (2000) to clearly define the discipline of technology in the twenty-first century as well as outline the characteristics of a technologically literate individual. ITEA, as well as other advocates including the National Academy of Engineering (NAE) and the National Research Council (NRC), agree that technological literacy is important for all people (Pearson & Young, 2002; Pearson, 2004; Gamire & Pearson, 2006; Daugherty, 2008; Terry, 2008). Despite the research and agreement that technological literacy is important for all people, pre-engineering programs, considered a specialized career and technical (CTE) education program, are changing technology education programs (Blais & Adelson, 1998). To aid CTE program areas, the technology education profession, and school districts, this study seeks to determine the perceptions of technology in high school students taking PLTW® courses in comparison to students taking technology education courses. This study is of importance due to the growing trend nationwide of technology education programs being replaced by pre-engineering courses and because of this trend, it is necessary to determine if there is a significant difference in student perceptions of technology from students who enroll and take technology education courses, Project Lead the Way® pre-engineering courses, and students not enrolled in either program.

STATEMENT OF THE PROBLEM

The purpose of this study was to compare high school student's perceptions of technology amongst each other and the general adult population's perception of technology.

RESEARCH GOALS

The following research questions were developed from the problem statement to guide this study:

1. Do high school students' perceptions of technology differ from adult's perceptions of technology?
2. Are the perceptions of technology the same for student's that complete a Project Lead the Way® pre-engineering course, students who complete the *Fundamentals of Technology* course, and students who are only enrolled in general education courses?
3. Do students who complete the *Fundamentals of Technology* course have the same perception of technology as students who complete a Project Lead the Way® pre-engineering course?
4. Do students who complete a Project Lead the Way® pre-engineering course have the same perception of technology as students who are enrolled in only general education courses?

5. Do students who complete the *Fundamentals of Technology* course have the same perception of technology as students who are enrolled in only general education courses?

BACKGROUND AND SIGNIFICANCE

This study was the result of several school districts in the state of North Carolina starting Project Lead the Way® pre-engineering programs as replacement courses for technology education programs, although it has been well documented (Rogers, 2005; Rogers, 2006; SREB, 2001; Lewis, 2004) in editorials and research of how PLTW® and technology education programs are not interchangeable courses. School districts, for numerous reasons, have still opted to replace their technology education programs with PLTW® pre-engineering programs. School district administrators reasoning for the replacement of technology education include:

- The belief that PLTW® programs can change the focus of technology education (Blais & Adelson, 1998);
- Not having an understanding that all people should be technologically literate (Gamire & Pearson, 2006);
- Not having an adequate understanding of the definition of technological literacy (Pearson & Young, 2002);
- Correlating technology education programs with courses of years past such as industrial arts and/or mechanical arts (Lewis, 2004); and
- Not having an adequate supply of technology education teachers to support their classes (Wicklein, 2006).

This study sought to determine if differences existed in perception of technological literacy between adults and students. Additionally, this study was designed to provide a measurable means of determining student's perceptions of technology when participating in technology education courses, PLTW® courses, and students not currently enrolled in either course. Whether or not technology education students perceive technology at a higher level than PLTW® students will be evaluated statistically. Additionally, student perception's of technology within both the technology education course as well as the PLTW® course will be compared to a group of students who are not currently enrolled in either course. The responses from each of the three student groups will be evaluated statistically to determine significance. The *ITEA/Gallup Poll* (2001/2004), an instrument that measures people's perceptions of technology will be administered to students enrolled in PLTW's® *Principles of Engineering* course, students enrolled in the *Fundamentals of Technology* course within the state of North Carolina, and a group of students not enrolled in either course.

LIMITATIONS

The following limitations were made concerning this study:

- The study used the *ITEA/Gallup Poll* (ITEA, 2001/2004) to assess people's perceptions of technology. It will serve as the only method of obtaining technology and technological literacy data.
- The study was conducted with a sample of high school students in the state of North Carolina.

ASSUMPTIONS

The following assumptions were made concerning this study:

- All students have a basic level of technological literacy which should not affect the reliability and validity of the study.
- The *ITEA/Gallup Poll* (ITEA, 2001/2004) can accurately assess high school students' perceptions of technology.

PROCEDURES

A sample of nine high schools offering Project Lead the Way's® *Principles of Engineering* courses, a sample of ten high schools offering the *Fundamentals of Technology* course, and a sample of ten high school general education classes were mailed a cover letter, an *ITEA/Gallup Poll* (2001/2004) instrument and supporting demographic questionnaire for review, and a set of instructions for the teacher to use when administering the online survey to the students.

The cover letter discussed the purpose of the study and thanked them for their participation in the project. The cover letter also instructed teachers to administer the instrument during the last few weeks of class. The teacher instruction sheet included details on how to administer the online survey to the students. The teacher was responsible for entering in specific demographic data for each student before the students were allowed to take the survey.

The *ITEA/Gallup Poll* instrument was created and published in part by the International Technology Education Association and the Gallup Organization (ITEA, 2004). The *ITEA/Gallup Poll* was tested for reliability and validity during its pilot study and has been used to survey a sample of the United States public twice to determine what the United States populace thinks about technology (ITEA, 2002/2004).

Data collected from the *ITEA/Gallup Poll* were compared using Pearson's chi-square to determine whether the percentages for the three groups were significantly different from one another. Data were calculated to describe student's perceptions of technological literacy in the PLTW® course, the *Fundamentals of Technology* course, and the general education courses. Items that were found to have a significant difference between the student groups were determined. Additionally, adult respondent data from the 2001 and 2004 *ITEA/Gallup Polls* were analyzed descriptively with the student data to determine similarities and/or differences between the student's responses and the adult's responses.

DEFINITIONS OF TERMS

The following operational definitions were assigned to the terms in this study by their intended meaning or by their meanings in the context of their cited references:

1. *Fundamentals of Technology Course*: An introductory course designed for North Carolina high school students that introduces students to what technology is, the historical, ethical, and societal structure of technology, and technological systems of the designed world.
2. *Introduction to Engineering Design* Course: A course in the PLTW® high school pre-engineering program which "...emphasizes the development of a design. Students use 3D computer software to produce, analyze, and evaluate models of project solutions [using the engineering design process]..." (SREB, 2005, p. 5).
3. Pre-engineering: "coursework of subjects that draw content from the work of engineers, and that promise engineering careers as likely fixtures of the schools who pursue them" (Lewis, 2004, p. 22).

4. Project Lead the Way® (PLTW®): Pre-engineering program for middle and high school students designed to interest students in the field of engineering with the intent to increase engineering and engineering technology program enrollments at the post-secondary education level (Blais & Adelson, 1998, p. 40).
5. Fundamentals of Technology: A North Carolina standards-based introductory technology education course for high school students.
6. Technology: "Human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities" (ITEA, 2000/2002, p. 242).
7. Technology Education: "A study of technology, which provides an opportunity for students to learn about the processes and knowledge related to technology that are needed to solve problems and extend human capabilities" (ITEA, 2000/2002, p. 242).
8. Technological Literacy: "The ability to use, manage, understand, and assess technology" (ITEA, 2000/2002, p. 242).
9. Technologically Literate Person: "[a person who] understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes society, and in turn is shaped by society" (ITEA, 2000, p. 9).

SUMMARY AND OVERVIEW

This chapter has introduced the background and significance of the study. Research questions were presented as well as the assumptions and limitations of the study. A definition of terms and procedures concluded the chapter.

Chapter II details a review of relevant literature. A historical perspective of pre-engineering education and technology education in the United States is provided as well as a detailed history and explanation of technological literacy. A review of current trends on high school pre-engineering and technology education and its current state-of-the-art is also discussed.

Chapter III presents components and methodology describing research. The research questions are presented with information on the population, sample, and instrumentation items. This chapter also includes procedures for data collection and statistical analysis procedures of the data collected.

Chapter IV describes the findings of the study. The results of the statistical tests are presented on the data collected and are reported in relation to the research questions.

In Chapter V, conclusions are drawn from data collected in the study. Recommendations and implications for further research studies are also presented.

CHAPTER II

REVIEW OF LITERATURE

Technology education has struggled to find a true purpose to the profession. While some believe technological literacy is the impetus of technology education, others argue that the profession should refine our discipline's scope to accentuate the engineering discipline. From its roots in specialized manual training to the progression into academia the profession has had difficulty in finding common ground on which to teach the technology discipline without a conscience effort to standardize the profession. Scholars like Paul W. DeVore sought to ratify the profession with technology as its content focus as far back as the 1960s but with the various philosophies and ideas regarding industrial arts education, little uniformity existed throughout the nation. With the adoption of *Standards for Technological Literacy: Content for the Study of Technology* in 2000, the technology education profession has took a large step in finding purpose and placing the discipline into the academic realm. Still, others believe that the technology education discipline should refocus technology education to better align with engineering education because of the great need in the United States for engineers and technical workers. This literature review seeks to aid in determining if an engineering focus would better communicate technological literacy than that of a broad-based technology education course.

This review focuses on three areas in regard to the possible shift of technology education into pre-engineering education. First, a historical perspective of the technology education discipline and technological literacy are presented. Additionally, identifying the need for a technologically literate society as well as ways for assessing technological literacy are discussed. Second, pre-engineering and engineering design are defined and methods of infusing pre-engineering into technology education are demonstrated. Moreover, prominent pre-engineering education programs and accompanying instructional materials are discussed. Lastly, the *ITEA/Gallup Poll* (2001/2004) and its purpose, construction, methodology, findings, and history are presented as this poll serves as the primary instrument used to obtain student's perceptions of technology and technological literacy.

TECHNOLOGICAL LITERACY

Even before the adoption of *Standards of Technological Literacy: Content for the Study of Technology* (ITEA, 2000/2002), scholars (DeVore, 1964; Dyrenfurth, 1987; Dyrenfurth, 1991; Todd, 1991), among others, have debated whether or not technological literacy should be the focus of technology education. William E. Warner's *A Curriculum the Reflect Technology* (1947) was the first curriculum designed to teach the discipline of technology as a school subject. Warner's curriculum is considered by many to be the impetus of technology education. Delmar W. Olson, Warner's doctoral student, utilized Warner's curriculum ideologies and integrated them into industrial arts courses. Olson's dissertation, *Technology and Industrial Arts: A Derivation of Subject Matter from Technology with Implications for Industrial Arts Programs* (1957) helped to integrate the technological concepts developed in Warner's work into the classroom through the creation of learning activities, sound teaching pedagogy, and conceptual understandings.

While Warner and Olson were developing industrial arts activities and teaching pedagogies which encompassed technological concepts, Paul W. DeVore viewed technology as more than just a collection of concepts and believed that technology was as intellectual as it was conceptual. DeVore's *Technology: An Intellectual Discipline* (1957) helped to refine the social, economic, cultural, ethical, and political considerations of the utilization of technology. It was not until after DeVore's research was conducted that the term technological literacy was synthesized throughout the profession. Dyrenfurth (1991) noted that DeVore (1987) strived to explore the meaning of technological literacy by asking "what does it mean to be literate in French or Russian?" (pp. 138-139). DeVore determined that being able to speak, write, and read the language were essential to being literate in a foreign language, but it was equally important to understand the history and culture of the countries where the language is primarily spoken in order to become fully literate. After exploring the meaning of technological literacy itself, DeVore sought to determine the context of technology. In order to develop this context, DeVore (1987) identified four basic systems that form technology's context including: ideological, sociological, ecological, and technological systems (Dyrenfurth, 1991, p. 142). Snyder and Hales (1981) adapted DeVore's four basic systems into three interrelated human adaptive systems in the *Jackson's Mill Curriculum Theory*. An illustration of this adaption is shown in Figure 1.

Although a context for technology is important to understand the different definitions of technology, having an encompassing definition of technology must be presented in order to develop an adequate definition for technological literacy. DeVore's definition is perhaps the most encompassing definition of technology. He stated "the study of the creation and utilization of adaptive means, including tools, machines, materials, techniques, and the technical systems, and the relation of the behavior of these elements and systems to human beings, society, and the civilization process is the field of technology" (DeVore, 1980, p. xi).

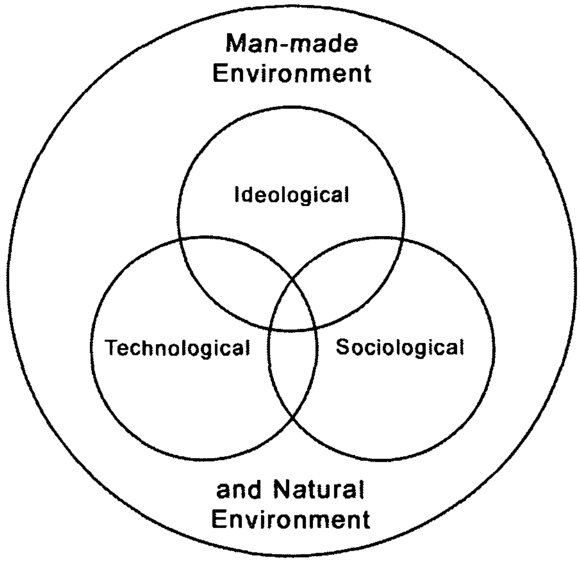

Figure 1. Human Adaptive Systems (Snyder & Hales, 1981, p. 7).

Dyrenfurth (1991), like Warner, discussed technological literacy as being the essence of technology (p. 173) and posed the question, "What is technological literacy?" (p. 155). Dyrenfurth described technological literacy through three approaches: a) the descriptive characteristics approach, b) the competency list approach, and c) the graphic approach. It is important to conceptualize technological literacy from these different viewpoints or "approaches" to fully understand the meaning of technological literacy.

In his descriptive characteristics approach, Dyrenfurth (1991) identified 12 operational definitions to help establish the concept of technological literacy. These definitions are varied and are taken from some of the more prominent leaders in the field of technology education, but the common theme between these definitions seems to stem from the ability to use and understand technology. Dyrenfurth stressed however that a person's understanding of technology does not make him/her technologically literate but being technologically literate "requires the ability to do technology, that is, to use it and not merely recognize technological processes" (p. 158). Dyrenfurth (1984) developed an order system for determining levels of technological literacy, which later evolved into Figure 2.

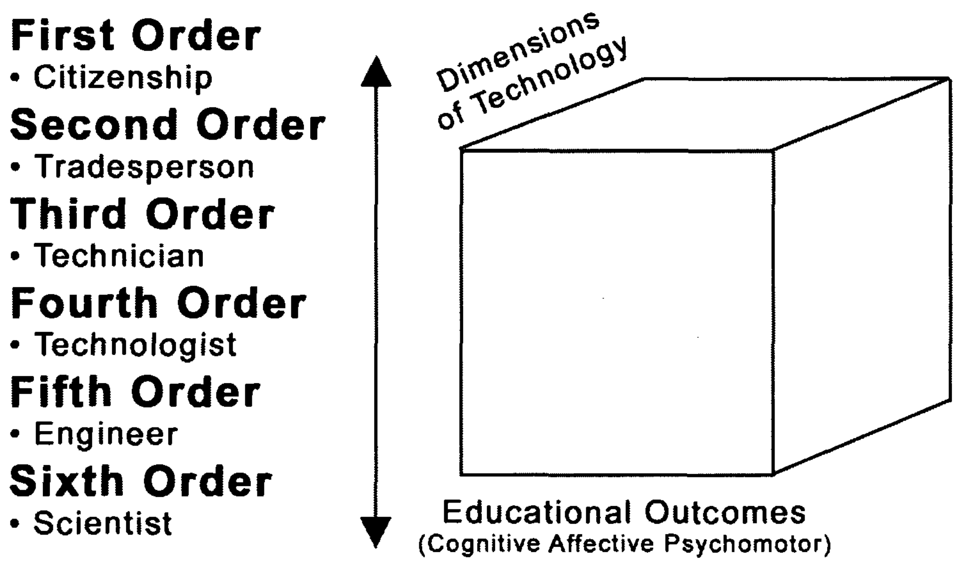

Figure 2. Levels of technological literacy (Dyrenfurth, 1991, p. 160).

The competency list approach, the second approach Dyrenfurth (1984) noted, sought to clarify technological literacy by developing a list of activities technologically literate people could perform and assess. Several studies such as the *Engineering Concepts Curriculum Project* (1971), Deforge's international work (1972), Foster and Perreault (1986), and Grodzka-Borowska and Szdlowski (1989) conducted similar competency lists which aided in clarifying the concept of technological literacy. Dyrenfurth (1991) noted that the "Engineering Concepts Curriculum Project's (ECCP) [competency] list may very well be the conceptual ancestor of the definitive technological literacy competency list" (p. 161). The ECCP noted that a technologically literate person:

- Can use the decision-making processes effectively;
- Can make valid predictions from models;
- Can use models to simulate real situations;
- Can use optimization techniques in making real world decisions as well as in classroom situations;
- Can demonstrate how feedback is used to control social, political, economic, ecological, biological, mechanical, and technological systems;
- Can predict from models when a system might become unstable;
- Can communicate with machines so that he or she uses the machine effectively;
- Is familiar enough with logic circuits to understand that complex computers are made from simple circuits;
- Is willing to use the tools of technology to attempt solutions to real problems;
- Probes for causal relationships between science, technology, and society;
- Questions the possible effects of technological "improvements" on the environment;
- Weighs the relative merits and risks of new products and processes;
- Recognizes the development of criteria and stating of constraints as subjective activities, and;
- Recognizes that technology will create entirely new possibilities for society. As a result the world will be a different place to live in the future, and that knowledge of both technology and humanity can insure that it will be a better place to live in (Engineering Concepts Curriculum Project, 1971).

Dyrenfurth's (1991) third approach, the graphic approach, recognizes the need to illustrate a concept in order to fully understand it. Dyrenfurth researched several graphical models (Daiber & Wright, 1981; McCrory, 1983; Dyrenfurth, 1984; Harrison, 1988) noting that "[these models] depict so many viewpoints and approaches to the challenges of technological literacy that it is simply beyond the scope of [this article] to even summarize" (p. 170). His quote conveys that there is little consensus as to the actual scope and graphical representation of technological literacy. McCrory's (1983) graphical representation of technological literacy shown in Figure 3 perhaps best illustrates technological literacy visually.

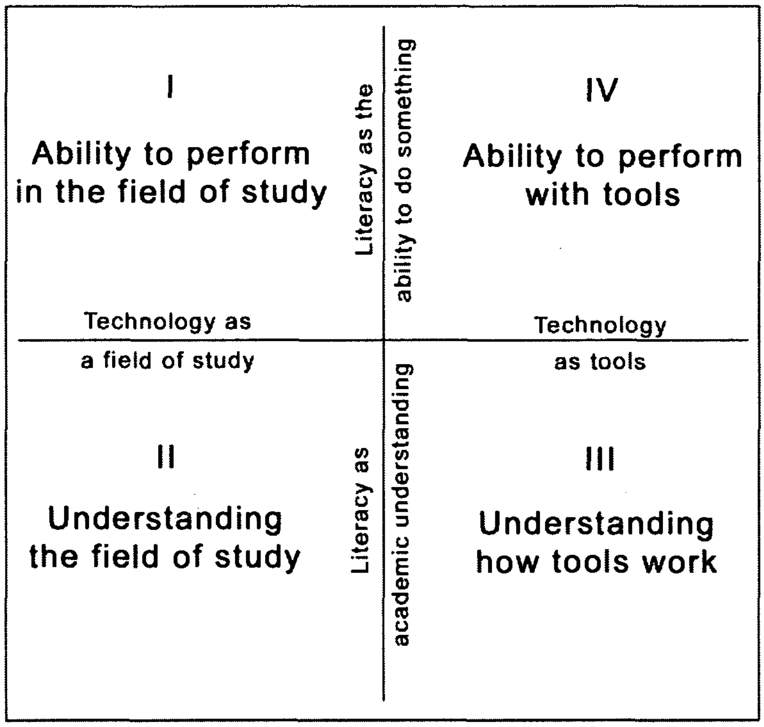

Figure 3. McCrory's 1983 technological literacy model (Dyrenfurth, 1991, p. 173).

It is of little surprise that scholars who conceptualized graphical illustrations, researched competency lists, or developed descriptive characteristics each had differing findings and opinions about the true meaning of technological literacy. Todd (in Dyrenfurth & Kozak, 1991) noted that "technological literacy is a term of little meaning and many meanings… it is a slogan of immense potential power for creating interest and commitment and it can serve as a theme underscoring the shortage of technologically literate people" (p. 10). Todd (1985) also determined that technological literacy can represent a slogan, a concept, a goal, or a program. Waks (in Todd, 1991) stated "technological literacy is best thought of as a slogan. It has little specific content, but it has a definite emotional appeal" (p. 11). Using technological literacy as a slogan promotes unity and a means to rally for a central theme. In response to Wak, Todd (1991) believed that using technological literacy as a slogan would confuse the general public about what constitutes technological literacy more than to clarify its meaning. Rather, he determined that a level and function of theoretical constructs could help to identify technological literacy as a concept. Todd (1991) explained these constructs as having a gradual increase in understanding and conceptualization. Exploration, level 1, served as a basic understanding of the concept where level 5 allowed people with a definitive understanding of levels 1-5 to harness and control technological literacy. Todd (1991) determined that the idea of technological literacy as a goal had not been supported but noted that "increased attention to the assessment and qualification of technological literacy should serve to extend [the] much needed professional dialogue on the scope of technological literacy as a goal" (p. 13). Lastly, the idea that technological literacy can be representative of a program stemming from the integration of courses such as technology education is beginning to integrate "both the language and activities of technological literacy into their goals and practices" (p. 14) and it helps to solidify technological literacy as being an essential element or guiding theme of such programs.

It is also important to note the myths and misconceptions Todd (1991) identified in his writings. He identified three dimensions of the misconceptions of technological literacy: "a) knowledge versus ability, b) technological understanding versus action, and c) disciplinary versus interdisciplinary" (p. 16). In the first dimension, knowledge versus ability, Todd explains that teachers much prefer to discuss technology rather than perform it. The reason for this, Todd (1991) explained that it is much easier to find a teacher who enjoys discussing technology but feels uncomfortable with actually performing a technological activity. Understanding versus action, the second dimension Todd identifies, discusses the conflict of whether the understanding of technology is sufficient and whether or not it translates understanding into performance or action for students to fully understand technology. Todd (1991) stated "for many in technology education, understanding is important but insufficient. Understanding is in essence only the first of several desired components" (p. 17). His third misconception, dealing with disciplinary versus interdisciplinary perspectives, strives to consider the specialization of a person's occupation. Being so highly specialized in a specific job can hinder people's own technological literacy. Todd (1991) suggests that it is often difficult for people to see the connections of their specialized training or occupation to that of other technological knowledge/information learned. Additionally, Todd (1991) believes that a truly technologically literate person can effectively see the connections between various knowledge bases that can be transferred and synthesized with one another.

Throughout this historical research, the concepts, approaches, definitions, constructs, and representations of technological literacy have been presented from a variety of scholars with both similar and differing viewpoints. Perhaps the most concise and practical representation and construct for technological literacy was created by the Committee on Technological Literacy which was a group commissioned by the National Academy of Engineering (NAE) and the Center of Education, a division of the National Research Council (NRC) (Pearson & Young, 2002). The committee was charged to develop a clear and concise vision for technological literacy in the United States and recommend ways to achieve the vision. Before the committee developed a vision for technological literacy, it first developed a context for the meaning of technological literacy. Their construct for technological literacy encompassed three interdependent dimensions: a) knowledge, b) ways of thinking and acting, and c) capabilities. These characteristics were developed with aid from the International Technology Education Association (ITEA) and their Technology for All Americans Project (TfAAP) which published *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000/2002). Listed below is a list of the characteristics of a technologically literate citizen developed by the committee.

Knowledge

- Recognizes the pervasiveness of technology in everyday life;
- Understands basic engineering concepts and terms, such as systems, constraints, and trade-offs;
- Is familiar with the nature and limitations of the engineering design process;
- Knows some of the ways technology shapes human history and people shape technology;
- Knows that all technologies entail risk, some that can be anticipated and some that cannot;
- Appreciates that the development and use of technology involve trade-offs and a balance of costs and benefits and;
- Understands that technology reflects the values and culture of society.

Ways of Thinking and Acting

- Asks pertinent questions, of self and others, regarding the benefits and risks of technologies;
- Seeks information about new technologies and;
- Participates, when appropriate, in decisions about the development and use of technology.

Capabilities

- Has a range of hands-on skills, such as using a computer for word processing and surfing the Internet and operating a variety of home and office appliances;
- Can identify and fix simple mechanical or technological problems at home or work and;

- Can apply basic mathematical concepts related to probability, scale, and estimation to make informed judgments about technological risks and benefits (Pearson & Young, 2002, p. 4).

Although a majority of Americans have a relatively low understanding and utilization of these characteristics, these dimensions help to convey the construct and essence of technological literacy (Pearson & Young, 2002, p. 68). Pearson and Young (2002) created a graphical representation of the three dimensions of technological literacy and show how they interact with one another. Figure 4 illustrates the three dimensions also denoting the "technological literacy space" occupied by most Americans (p. 69).

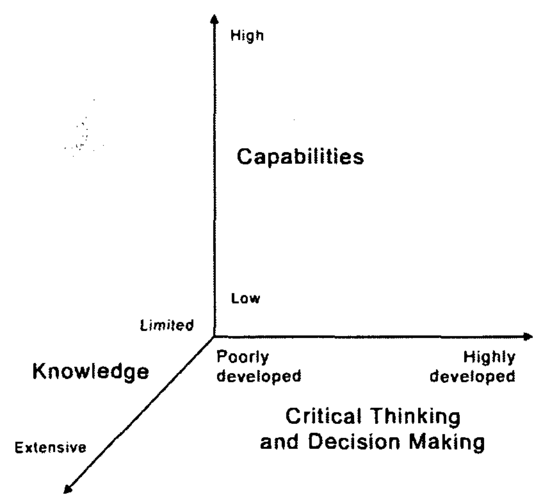

Figure 4. The dimensions of technological literacy showing the "space" occupied by most Americans (Pearson & Young, 2002, p. 69).

THE NEED FOR A TECHNOLOGICALLY LITERATE SOCIETY

A society whose citizenry is technologically literate understands that technology is related to many aspects of their lives (Pearson & Young, 2002) and appreciates that technology is neither good or bad but the effects of the use of technology can have both positive and detrimental impacts. Pearson and Young (2002) also note that technologically literate people are able to debate and discuss technological issues in a public forum and are able to make well-informed decisions regarding technological matters in conjunction with laws and ordinances that may pertain to the technology or technologies involved.

Reed (2007) and Dyrenfurth (1991) referred to other academic subjects and how they become courses of study. Reed (2007) noted that significant issues exist for academic subjects which are not mainstreamed and required for students to enroll in today. There were specific reasons for subjects to be introduced and taught to students. Language arts and reading skills were taught to children so they could read the Holy Bible. Mathematics and history were commissioned to help students "manage their affairs" and "improve the citizens' moral and civic virtues" (Urban & Wagoner, 1996, p. 72). Meade and Dugger (2005) presented the *Technology for All Americans Project* (TfAAP) and the resulting documents in their publication *Technological Literacy and Standards: Practical Answers and Next Steps*. As part of the TfAAP, the *Rationale and Structure* publication (ITEA, 1996) helped to provide validation to the importance of technological literacy. This document helped to provide a framework for the actual technological literacy standards documents: *Standards for Technological Literacy: Content for the Study of Technology* (STL) (ITEA, 2000/2002) and *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards* (ITEA, 2003). Meade and Dugger (2002) cited Rose and Dugger (2002) and Rose, Gallup, Dugger, and Starkweather (2004) to help research American citizens' knowledge and abilities pursuant to technological literacy. Their research presented "definable data" about the need for technological literacy and how "technology education can help to achieve technological literacy" (p. 33). Reed (2007) discussed how the acceptance of STL has helped to foster a need for technology education in the academic arena and how it would help students to become technologically literate. Dugger (2007) noted that although STL has been adopted by many state education departments around the country, technology education is only a requirement in twelve states.

Newberry and Hallenbeck (2002) discussed the role of standards in different subject areas by the establishment of standards documents. Newberry and Hallenbeck (2002) stated that "standards [documents] have established desired outcomes in given subject matter fields, which results in the subject matter educational systems being revamped to achieve the desired outcomes" (p. 45). As with the case for mathematics, science, and technology standards, Newberry and Hallenbeck (2002) noted that standards documents help guide teachers in their roles to determine student learning and understanding. Additionally, they discussed the relationships between technology education standards (STL) and similar subject areas like mathematics and science. Newberry and Hallenbeck (2002) pointed out that two standards – Standard E: Science and Technology and Standard F: Science in Personal and Social Perspectives from the National Science Education Standards both recognize the need for technological literacy and "enables science and technology teachers to demonstrate the distinctions between science and technology, yet make the connections of science while minimizing the idea that technology is applied science" (p. 17). Newberry and Hallenbeck (2002) also related STL to the National Council of Teachers of Mathematics' (NCTM) *Principles and Standards for School Mathematics* (2000) noting that "technology and mathematics educators can find value in reading and referencing both documents to produce students who can globally compete in tomorrow's world" (p. 39).

Reed (2007) believes that there is promise of further enhancing a technologically literate citizenry in the United States as the National Academy of Engineering (NAE) and the National Research Council (NRC) have supported STL through a variety of publications like *Technically Speaking: Why All Americans Need to Know More About Technology* (2002) and *Tech Tally: Approaches to Assessing Technological Literacy* (2006). Education centers, such as those sponsored by the National Science Foundation (NSF) have also adopted technological literacy as one of their interests. The National Center of Engineering and Technology Education (NCETE) has developed a series of themes which aid in illustrating and demonstrating the need for technological literacy. These themes include:

- How and what students learn in technology education;
- How to best prepare technology teachers; and
- Assessment and evaluation for technological literacy (Reed, 2007, p. 18).

These themes help to provide an organized and logical map in order to determine how technological literacy can be incorporated into general education either through the incorporation of these themes in courses already offered or through the creation of another course which specifically addresses these themes. Regardless of how technological concepts are presented, Meade and Dugger (2005), Reed (2007), as well as Hailey, Ereckson, Becker, and Thomas (2005) agree that technological literacy standards need to be implemented as an integral part of K-12 education in schools across the United States.

WAYS FOR ASSESSING TECHNOLOGICAL LITERACY

By clearly and succinctly defining the term technology and technological literacy as well as developing a rationale for a technologically literate citizenry, it is apparent that there must be assessments to measure a person's technological literacy aptitude. Deal (2002) was among the first to make the connection of technological literacy and technology assessment after the publication of STL. He noted that one of the major goals of technology education was to develop or "provide a pathway" for technological literacy for students who enroll in technology courses. He discussed that technology teachers should not only focus on the technical content of a particular technology but rather focus on the concept of technological literacy as a process.

Custer (2001) researched assessment standards for technological literacy and discussed assessment strategies other academic disciplines have used. He noted that although STL had only been published for a short time, technology educators for years have been at the forefront of assessment practices unlike many other disciplines. Technology educators historically have utilized both formative and summative assessments, whereas other disciplines have concentrated their efforts primarily on summative evaluation. He also noted that other disciplines are now beginning to "discover the value of rich information about student's learning that is woven throughout the process of learning" (p. 25). Custer (2001) did discuss the problems technology teachers faced as opposed to other disciplines which was the lack of clearly defined learning goals and criteria for technology education. This lack of learning goals and criteria often hindered a technology teacher's ability to assess his/her student's understanding of technological concepts. With the adoption of STL, Custer (2001) believed that the lack of goal clarity has been addressed by the structure of STL by incorporating "clearly articulated criteria spanning K-12 that are targeted on what students *know* and *are able to do*" (p. 26). Custer (2001) noted that the next goal of technology education was to develop assessment standards which appropriately and adequately assess student's understanding and ability to do technological literacy. To accomplish this goal, the ITEA commissioned an assessment standards team whose charge was to "provide teachers, administrators, and other decision makers with a set of criteria to use as they assess student knowledge and performance" (p. 28). The assessment standards were developed for teachers to assess their student's knowledge and performance aligned with STL.

Engstrom (2005) helped to describe a five-step approach to defining assessment indicators based on ITEA's (2004a) *Measuring Progress: Assessing Students for Technological Literacy* publication. Engstrom (2005) stated "for students to become technologically literate, it is important that the teacher understands how to measure student understandings and abilities in the study of technology" (p. 30). Referring to Pearson and Young's (2002) dimensions of technological literacy (Figure 4), Engstrom (2005) believed that in order to effectively assess the dimensions, the design and development of quality assessments must begin before an instructional unit is started and must progress through the entire unit, not just at the conclusion. To further his opinion, Engstrom combined the assessment indicators described in *Measuring Progress* with Wiggins and McTighe's *Backwards Design Process* (1998) to effectively describe the five assessment indicators for technological literacy:

1. Identify content standards and appropriate benchmarks;
2. Extract and organize content;
3. Define assessment criteria;
4. Select and use assessment tools and/or methods; and
5. Make use of assessment results (Engstrom, 2006, pp. 31-32).

Noting that one of the most challenging parts of creating quality assessments devices is alignment, Engstrom (2005) utilized a graphic adapted from Wiggins and McTighe (2001) with the assessment methods presented in the *Measuring Progress* publication. Figure 5 depicts how to align assessment purpose with proper assessment techniques in regard to technological literacy. Engstrom's graphic has page numbers referenced with each assessment method. These page numbers refer to content in *Measuring Progress.*

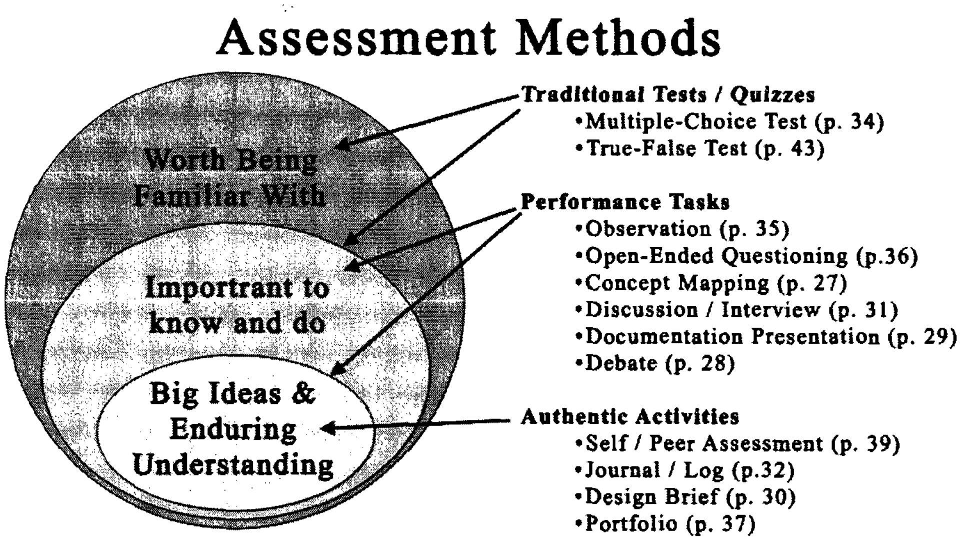

Figure 5. Aligning Assessment Purpose with Assessment Techniques (Engstrom, 2006, p. 32).

It is apparent that assessing technological literacy aptitude of students who take technology education courses in K-12 public education has begun to take place although Pearson (2006) commented that there is very little research that shows what children or adults know, can do, and believe about technology. To combat this issue and to research the prospects for the assessment of technological literacy, the Committee on Assessing Technological Literacy was formed and chaired by Elsa Gamire, a National Academy of Engineering (NAE) member and an engineering professor at Dartmouth College. The 16-

person committee included experts in the fields of learning and cognition, assessment, informal education, opinion-survey research, technology education, and K-12 education reform. Pearson (2006) noted that the goal of the committee and project was:

> … to determine the most viable approach or approaches for assessing technological literacy in three distinct populations in the United States: K-12 students, K-12 teachers, and out-of-school adults. The National Science Foundation-funded project had two specific objectives:
>
> - Assess the opportunities and obstacles to developing one or more scientifically valid and broadly useful assessment instruments for technological literacy in the three target populations; and
> - Recommend possible approaches to be used in carrying out such assessment instruments, including the specification of subtest areas and actual sample test items representing a variety of item formats (p. 25).

The committee's report, *Tech Tally: Approaches to Assessing Technological Literacy* (Gamire & Pearson, 2006), makes twelve recommendations in five areas including: instrument development, research on learning, computer-based assessment methods, framework development, and public perceptions of technology. The report noted that "until technological literacy is assessed in a rigorous, systematic way, it is not likely to be considered a priority by policy makers, educators, or average citizens" (Pearson, 2006, p. 25).

To determine the currently available technological literacy assessments already being used throughout the world, the committee commissioned two extensive literature reviews on the topics of learning related to technology (Petrina & Guo, 2004), and learning related to engineering (Waller, 2004). Petrina and Guo (2004) describe ITEA's definition of technological literacy as a way to "provide clear content domains for constructing a bank of items to select an instrument [which could make] comparisons of technological literacy easily created" (p. 158). Petrina and Guo (2004) also note that technological literacy can indeed have greater meaning than ITEA's definition and with similar organizations' and programs' definitions (e.g., International Society for Technology in Education; Educational Testing Service; science, technology and society; etc.) can serve to "muddy the waters" in regards to a true definition of technological literacy (p. 158-159). Petrina and Guo's (2004) study surveys a number of large-scale technological literacy assessments and notes the complexity and challenges in developing and administering these assessments.

The Pupil's Attitudes Toward Technology (PATT) instrument is a large-scale attitudinal assessment of technology considered to be one of the better known and sustaining assessment studies ever developed (Petrina & Guo, 2004). Petrina and Guo (2004) believe that the notoriety and sustainability of this assessment is because of its open-source philosophy. The PATT instrument was developed in the mid 1980s by Jan Raat and Marc de Vries at Eindhoven University in the Netherlands and was used to assess attitudes, values, and general understandings of technological concepts. By 1987, over twenty countries had used the PATT instrument to aid in assessing people's technological literacy aptitude (Raat et al., 1987 in Petrina & Guo, 2004). In 1988, de Vries, along with Allen Bame and Bill Dugger at Virginia Tech, revised the PATT instrument for use in middle schools throughout the United States (Bame et al., 1993 in

Petrina & Guo, 2004). Over 10,000 middle school students from seven states participated in the first PATT U.S. assessment. Today, the PATT assessment is considered one of the most reliable and popular assessments for comparing student's attitudes and values toward technology. Another aspect which makes the PATT instrument popular is that it is easy to administer to students as it is a pencil and paper instrument which has 100 Likert-type items. Bame et. al. (1993) did note a potential fallacy of the PATT instrument as there is a "significant difference" in students' attitudes toward technology who have taken a technology education course as opposed to those students' attitudes who had not taken a technology education course (p. 46). It should be noted that the PATT instrument was developed to collect attitudinal data toward technology and was not designed to assess people's level of technological literacy or people's perception of technological literacy for which the *ITEA/Gallup Poll* was designed for the latter (Dugger, personal communication, February 10, 2009).

Another large-scale assessment of technological literacy that Petrina and Guo (2004) presented in their literature review was the Third International Mathematics and Science Study (TIMSS). TIMSS was a large-scale assessment which involved 1.3 million fourth and eighth grade students in 49 countries throughout the world and was implemented in 1995 and 1999 (Howie, 1999 in Petrina & Guo, 2004). The study involved both a cognitive assessment and a performance assessment section for students to complete. While scholars (Orpwood & Garden, 1998) suggest that TIMMS encompasses a technological literacy assessment component, Kendall and Marzano (1997) and others note that large scale assessments which the National Assessment of Education Progress (NAEP) commissions for high status subjects (civics, economics, foreign language, geography, mathematics, reading, U.S. history, world history, writing) does not assess technology and technological studies (p. 160). Petrina and Guo (2004) do find it refreshing however that the "economics of scale suggest that assessment specialists in technology education would do well to link technological literacy to TIMSS 2007" (p. 160).

The British seem to have the most experience of assessing technological literacy on a large-scale especially in regards to including a significant technological performance component in their assessments (Petrina & Guo, 2004). Led by Richard Kimbell, the Assessment of Performance Unit (APU) at Goldsmiths College collected and analyzed over 20,000 performance artifacts ranging from design brief summaries to drawings and prototypes from various technological designs during their 1988-1989 study. The collected artifacts were from over 10,000 students from 700 schools throughout England. To assess these artifacts, the APU assigned and trained 120 raters whose primary purpose was to "attempt to provide norms of ability or design cognition for (various) age groups" (Kimbell, Stables, & Green, 1996, pp. 48-86 in Petrina & Guo, 2004). The outcomes from this study help to make design and technology (technology education) a required subject area in the National Curriculum of England.

Although Petrina and Guo (2004) discuss several other large-scale technological literacy assessments in their commissioned literature review, the PATT, TIMSS, and APU studies are often recognized as the assessments which had the largest populations participate. Petrina and Guo (2004) also note that other studies (Kempton, Bosterm, & Hartley, 1996; ITEA/Gallup Poll, 2002/2004) could be considered large-scale not because of the size of the people participating in the study, but due to the research scope and/or implications for the studies. Additionally, Petrina and Guo (2004) argue that standardized tests for teacher licensing such as the Educational Testing Service's Praxis II: Technology Education (0050) could be used as an assessment for technological literacy as the test encompasses a variety of technologies. Concluding their review, Petrina and Guo (2004) state:

> The time is right for someone to offer a Third Way for assessments of technological literacy. Where large-scale efforts offer the benefit of standardization (i.e., reliability and validity), inferential measurement of individuals and small-scale efforts offer a benefit of customizability for local nuance, performance assessment, and narratives. A Third Way might mediate between and balance the two with an emphasis on collective technological literacy. A Third Way might omit individual assessments in favor of social group assessments and accommodate for a quantification of team performance and the qualification of collective stories growing up in a contradictory and increasingly technological world (p. 171).

To accomplish Petrina and Guo's (2004) concept of creating a "Third Way" for the assessment of technological literacy, Custer and Pearson (2006) describe how the National Academies are making the case for assessing technological literacy through developing a conceptual framework for technological literacy. Custer and Pearson (2006) refer to the National Academy of Engineering (NAE) and National Research Council's (NRC) publication *Technically Speaking* when determining the value of technological literacy and the potential benefits the American public would receive if an assessment of technological literacy was developed. Custer and Pearson (2006) note however that in today's United States educational system and its high stakes testing environment, it is often difficult to mandate additional assessments for K-12 students. Because of current laws such as the No Child Left Behind Act (NCLB), pressure has been placed on schools to show significant gains on achievement in reading and mathematics regardless of situation/scenario the school may be facing. Because of the national laws and mandates such as NCLB and the fact that technological literacy does not necessarily have a connection to a core subject area in K-12 education such as reading, writing, science, or mathematics, Custer and Pearson (2006) believe that "unless or until there is a greater emphasis in K-12 classrooms on curricula that encourage the study of technology, it is hard to imagine a widespread, school-based assessment of technological literacy" (p. 21).

To increase the study of technology in K-12 education, recent publications such as *Standards for Technological Literacy* (ITEA, 2000/2002), *Advancing Excellence in Technological Literacy* (ITEA, 2003), and *Technically Speaking* (Pearson & Young, 2002) each aid in developing a way to rationalize and structure the content of technology. It was not until the NAE and NRC's *Tech Tally* (Gamire & Pearson, 2006) publication that a conceptual framework for technological literacy was developed and presented. Figure 6 presents *Tech Tally's* two-dimensional matrix for the conceptual framework of technological literacy that is designed similarly to the science and mathematics frameworks developed by NAEP. The cognitive dimension of the matrix includes *Technically Speaking's* three dimensions of technological literacy (knowledge, capability, and ways of thinking). The content dimension of the matrix (technology and society, design, products and systems, characteristics, core concepts, and connections) are essentially STL's five categories combined into four.

COGNITIVE DIMENSIONS

CONTENT AREAS		KNOWLEDGE	CAPABILITIES	CRITICAL THINKING AND DECISION MAKING
	TECHNOLOGY AND SOCIETY			
	DESIGN			
	PRODUCTS AND SYSTEMS			
	CHARACTERISTICS, CORE CONCEPTS, AND CONNECTIONS			

Figure 6. The two-dimensional matrix for the conceptual framework for assessing technological literacy (Gamrie & Pearson, 2006, p. 5).

In order to establish and mandate the use of a means for technological literacy assessment in the United States, Custer and Pearson (2006) propose two options that could increase the likelihood of the mandate. One option is to include technology-related test items on existing national core academic assessment, which currently assess subject areas such as mathematics, science, history, etc. The second option would be the development of a new assessment which encompasses both dimensions (content areas and cognitive dimensions) of the conceptual framework for the technological literacy matrix. Custer and Pearson (2006) note criticisms for both options describing that simply including technology test items would not necessarily or accurately assess all three dimensions of technological literacy. The second option would require students to take yet another government-regulated standardized assessment which would have the ability to assess all aspects of the literacy model except the capability dimension of technological literacy.

To properly assess capability, Custer and Pearson (2006) believe that it would be pertinent to incorporate a form of performance assessment which could essentially measure students' abilities to apply "... general design and problem-solving processes, using basic tools for practical purposes, and performing simple repairs on household devices" (p. 26). Custer and Pearson (2006) note Kimbell's *Assessment of Performance in Design and Technology Project* (1991) when determining the viability of such technology-related performance assessments that have taken place in the past. Another way to assess capability through performance is through the utilization of a simulated environment. *Tech Tally* includes a chapter of simulated and virtual performance assessments which have been conducted in years past as well as a justification for using simulation assessments.

Petrina and Guo (2004) predicted that the Educational Testing Service (ETS) would enter into the technological literacy assessment arena as they believed there was money to be made in developing measures for technological literacy. Dugger and Starkweather later affirmed this prediction by noting that ETS was in the process of developing technological literacy assessment items for use in the National Assessment of Education Progress (NAEP) assessments (Dugger & Starkweather, personal communication, October 1, 2009). Additionally, as new technology curriculum projects come online, such as ITEA's *Engineering by Design*™ (EbD™) curriculum model, assessments are being created which assess all three dimensions of technological literacy aligned with the curriculum content (Burke, personal communication, October 2, 2009).

Still, researchers (Daugherty, 2008; Pearson, 2004; Ritz, 2006; Lewis, 2004) debate the best way to not just assess technological literacy but to have students to enroll and take technology-related courses where they would learn about technological concepts and technological literacy. Wicklein (2006) believes that using an engineering design focus to teach technological concepts would intrigue students to enroll in courses related to technology. Rogers' and Rogers' (2005) study showed that technology education benefits from the inclusion of pre-engineering education. Pearson (2004) states that "there may be few other issues more important to technology education at this moment than the nature of the profession's relationship to engineering" (p. 66). Pearson (2004) believes that it is imperative for the technology education profession to establish a working relationship with the engineering education profession with the goal of technological literacy for all.

PRE-ENGINEERING EDUCATION

Lewis and Newell (2008) believe that the technology education profession is once again "contemplating another stage in its metamorphosis by adopting methods of the engineering profession as content" (p. 13). In order to understand the reasoning for the adoption of these engineering principles into technology education, it is important to have a historical perspective of the engineering profession as it relates to technology education and technological literacy. Lewis and Newell (2008) suggest that Americans learned the value of engineers by viewing engineer's roles in building European countries during the late 17th and early 18th centuries (p. 14). Pfammatter (2000 in Lewis & Newell, 2008) explains that American engineering was conceived from the industrial movement in Europe and was fueled in America by the belief that science and technology were important attributes to the progress and growth of a nation (p. 14). Benjamin Franklin and Thomas Jefferson, among others, believed these attributes were indeed important to the growth of America as a nation and believed that if citizens gained useful knowledge - knowledge that is put to use in everyday situations - they would be able to elevate their cultural standing and class (Pfammatter, 2000) in Lewis & Newell (2008).

To teach citizens “useful knowledge”, reformers such as Timothy Claxton and William Maclure saw the need to bridge the gap between the elite and the artisan societies by introducing mechanic institutes to the United States (p. 16). Stevens (1990 in Lewis & Newell, 2008) noted that through the establishment of these mechanic institutes and through the growth of industrialization throughout the country, the practice of workshop came to gain legitimacy as valid knowledge. With America’s growth approaching exponential rates, Pfammatter (2000 in Lewis & Newell, 2008) believed that the spread of mechanic institutes throughout the country was due to the need of developing transportation systems in order to discover new American territories as well as a way to develop energy sources at those new territories. The growth and expansion of America continued to increase the driving need for qualified engineers and the status quo was unchanged until 1876 when Calvin Woodward of Washington University in St. Louis learned the Russian model of manual training. Woodward saw the potential use of the Russian model in public education and established the Manual Training School of St. Louis. The school’s goal was to combine liberal arts with mechanic arts in order to teach the whole student. The Manual Training School of St. Louis is considered the birthplace of technology education in the United States, and its roots are clearly grounded in the principles and competencies of the engineering profession. The Morrill Act of 1862 helped to establish land grant universities throughout the United States which shared Woodward’s vision for manual training. It is important to note, however, that the engineering profession has since been categorized into differing fields such as: electrical, mechanical, chemical, civil, etc., which has in turn limited the scope of an engineer's general engineering knowledge base. For these reasons, modern engineering programs in colleges and universities begin with general engineering courses relevant to all engineering disciplines (Lewis, & Newell, 2008).

In today's public education system, general engineering courses similar to those taught in colleges and universities are further generalized and often named pre-engineering (Lewis, 2004). Lewis (2004) defined pre-engineering as "… coursework or subjects that draw content from the work of engineers, and that promise engineering careers as likely futures of the students who pursue them" (p. 22). Lewis' (2004) definition makes a case that pre-engineering courses should be taken by students who want to gain an understanding of the engineering profession as well as those students who have a vested interest in becoming engineers. In their closing remarks however, Lewis and Newell (2006) believe that the engineering profession and the technology education profession share several commonalities including the ultimate desire for all citizens to be technologically literate. This belief is echoed by other scholars (Daugherty, 2008; Ritz, 2006; Terry, 2008; Gorham, 2002; Childress & Rhodes, 2008) in the technology education profession. The dilemma in this belief is the establishment of a line between teaching technology-related concepts and engineering-related concepts in technology education courses.

INCLUDING ENGINEERING CONTENT INTO TECHNOLOGY EDUCATION

Technology education has begun to gain greater acceptance as a school subject in the United States with the adoption of STL (Lewis, 2004). Scholars (Wicklein, 2006;

Gattie & Wicklein, 2007; Rogers, 2005; Dearing & Daugherty, 2004) and others believe that engineering principles and concepts should be infused in technology education courses to increase the curricular value of technology education courses. Pearson and Young (2002) echo these remarks stating that engineering concepts should be made accessible to all people and engineering design should be included in the United States' general education curriculum. With technology gaining greater acceptance, and the fact that the National Academies and National Research Council (NRC) encourages the implementation of engineering design concepts in general education, Lewis (2005) considers the best way to infuse these engineering principles into general education is through technology education as this would also help to advance the goal of technological literacy for all.

Dearing and Daugherty (2004) were among the first to consider how STL has provided an opportunity to move technology education and pre-engineering closer together. Because of the partnerships nurtured during the development process of STL, organizations like the International Technology Education Association (ITEA), NRC, and the National Science Foundation (NSF), among others, have a vested interest in technology education and pre-engineering. Dearing and Daugherty's (2004) research study sought to generate a list of core pre-engineering concepts that should be delivered in technology education courses. The study used a modified Delphi research technique in which experts in both technology and engineering education were identified. The research question for the study asked the experts: What are the core concepts of engineering that need to be taught in a standards-based secondary level technology education program that is focused on pre-engineering? Figure 7 depicts the top nine engineering concepts and their consensus ranking. Dearing and Daugherty (2004) noted that of the top ten ranked concepts identified, each concept dealt with teamwork, communicating ideas, interpersonal skills, coping with change, technological literacy, brainstorming, appropriate technology, and how technology and engineering affect the environment. They noted that a consensus between technology teachers, technology teacher education, and engineering educators did not always exist and they believed that the differences were prominent mainly due of the populations they each serve. Dearing and Daugherty (2004) state that "technology teachers deliver curriculum that is broad in scope, while engineering educators interact with populations made up of students who have, in most cases, already made career decisions where the curricular focus is much more narrow and intensive" (p. 11).

Consensus Rankings Sorted by Standard Deviations and Mean Score (ranked)

Q#	Concept	Mean	SD
14	Interpersonal Skills: teamwork, group skills, attitude, work ethic	5.000	0.000
02	Ability to communicate ideas: verbally, physically, visually, etc.	4.818	0.405
26	Working within constraints/parameters	4.545	0.522
48	Experiences in brainstorming and generating ideas	4.455	0.522
25	Product design assessment: Does a design perform its intended function?	4.091	0.539
28	Troubleshooting of technological devices and systems	4.091	0.539
21	Understanding mathematical equations and relationships within equations	3.909	0.539
31	Basic knowledge of the various engineering fields	3.182	0.603
32	Experiences with the development of a personal portfolio	3.182	0.603
60	Basic computing skills: word processing, spreadsheets, Web page design, etc.	4.000	0.632

Figure 7. Consensus Rankings of Engineering Concepts Needed to be Taught in Standards-based Technology Education Programs (Dearing & Daugherty, 2004, p. 11).

Based on their results, Dearing and Daugherty (2004) believe that in order for pre-engineering concepts taught in technology education to become worthwhile to post secondary engineering programs, curriculum materials will need to be developed which stress the philosophical differences between the different professions.

Wicklein (2006) tends to agree with Dearing and Daugherty (2004) as he developed five good reasons to use engineering design as the focus of technology education. His reasons were developed from an earlier study which sought to identify the critical issues and problems facing the field of technology education. From Wicklein's (2005) study, three rationales that directly affect the issue of focus in technology education were determined. These three rationales were:

- Inadequate understanding by school administrators and counselors concerning technology education;
- Inadequate understanding by the general populace concerning technology education; and
- Lack of consensus of curriculum content for technology education (pp. 25-26).

To expand these rationales, Wicklein (2006) listed five benefits for having engineering design as the academic focus for high school technology education. These benefits include:

- Engineering design is more understood and valued than technology education by the general populace;
- Engineering design elevates the field of technology education to higher academic and technological levels;
- Engineering design provides solid framework to design and organize curriculum;
- Engineering design provides an ideal platform for integrating mathematics, science, and technology; and
- Engineering design provides a focused curriculum that can lead to multiple career pathways for students (pp. 26-29).

These benefits echo Gattie and Wicklein's (2007) study which proposed that technology education is "fertile ground" for the development and implementation of science, technology, engineering, and mathematics in K-12 education (p. 7). They note that design has already begun to be infused into technology education programs around the United States but the meaning and interpretation of design are not necessarily consistent within technology programs. To properly infuse engineering design into technology programs around the country, the National Center for Engineering and Technology Education (NCETE) was developed with grant support from the National Science Foundation. As partners with NCETE, Gattie and Wicklein (2007) developed a study that surveyed in-service K-12 technology education teachers about the incorporation and utilization of engineering design in their courses. It is interesting to note that the vast majority (90%) of the surveyed teachers already include engineering concepts and engineering design in their curricula, but over half (53.2%) are not satisfied with their instructional materials. Additionally, respondents believed that an engineering design curriculum would add value to the field of technology education by: clarifying the focus of the field (93% agreement); providing a platform for integration with other school subjects (96.7% agreement); elevating instructional content (88.4% agreement); increasing student interest in mathematics and science (89.3% agreement); and providing additional learning opportunities for students (94.4% agreement) (pp. 10-11).

Each of these survey items and respondent's answers closely mimic Wicklein's (2006) five benefits for having engineering design as the focus for technology education and seem to support his argument. Gattie and Wicklein (2007) confirm Wicklein's (2006) belief by stating "respondents appear to agree that engineering design is the appropriate approach for clarifying the focus of technology education" (p. 17). Although the data support this belief, technology teachers also realize their own limitations for infusing engineering design into technology education programs due to their own academic abilities and resources.

Rogers' (2005) study was similar to Gattie and Wicklein's (2007) study with the development of similar research questions. Rogers' (2005) study however, was limited to Indiana technology education teachers and how they embraced pre-engineering education and the teachers' perceived value of pre-engineering from a variety different demographics. Rogers (2005) was also interested in technological literacy and how it was affected through the inclusion of pre-engineering concepts in technology education courses. Rogers (2005) examined Project Lead the Way® (PLTW®) as the primary pre-engineering content infused in the technology education programs in both middle and high schools in Indiana.

His findings were similar to that of Gattie and Wicklein's (2007) overall, as his respondents perceived pre-engineering "as a valuable component of technology education" (pp. 12-13). Over 95% of the respondents (n = 59) believed that pre-engineering was either a "very valuable" or "somewhat valuable" component of technology education. It is interesting to note that a difference existed between the PLTW® teachers surveyed and the Non-PLTW® teachers surveyed. Eighty-eight percent (n = 30) of the PLTW® teachers noted that pre-engineering was a "very valuable" component of technology education, while 46.4% (n = 13) of the Non-PLTW® teachers believed pre-engineering to be "very valuable". In his conclusion, Rogers (2005) admits that PLTW® teachers are nearly twice as likely to rate pre-engineering as a very valuable component of technology education than as their non-PLTW® teacher counterparts. Because of this discrepancy, teachers with a background in pre-engineering seem to value pre-engineering much more than teachers without a background. Although these are teacher perceptions, the question remains: does technology education benefit from the inclusion of pre-engineering education into their programs?

Rogers and Rogers (2005) asked this very question and attempted to differentiate between technology education and pre-engineering. Rogers and Rogers (2005) believe that both programs share similar goals with a few key differences. They believe that pre-engineering education focuses on preparing students for careers in engineering and serve as preparatory courses for future education at the post-secondary level. Technology education programs seek to provide students with "general technological literacy applicable to every career field" (p. 89). McAlister, Hacker, and Tiala (2008) echo this sentiment but their concern regards the direction in which the infusion of pre-engineering into technology education will take the profession. They believe that the infusion will either take the general technological literacy approach where courses are designed for all students or the pathway to engineering approach which would prepare high school students who take these classes for post-secondary engineering programs. Salinger (2005) in Johnson, Burghardt, and Daugherty (2008) stated that "the study of engineering is not vocational; it is a way of thinking" (p. 2).

Rogers and Rogers (2005) offer three benefits of the inclusion of pre-engineering education in technology education. These benefits include: eliminating the view that technology education is not essential in school curricula, increasing student's technological literacy, and promoting increased academic rigor and relevance in technology education. Although each of these three benefits seem worthwhile to the profession, there is very little data to support these benefits outside of perception and attitudinal research. Johnson, Burghardt, and Daugherty (2008) believe that for the advancement of a discipline through the infusion of pre-engineering in technology education, research must be guided by fundamental principles, agreed upon by the discipline's research community, and that community must pose questions that can be investigated empirically. In their study comparing engineering and technology education, Johnson, Burghardt, and Daugherty (2008) summarized that technology education research was very descriptive in nature or encompassed case study methodology whereas engineering education research relied on more quantitative research methods. Additionally, they found that very little empirical research on problem solving and design had been conducted although these issues are essential to both the engineering and technology education fields. In their concluding remarks, Johnson, Burghardt, and Daugherty (2008) state that:

> ...it is very important at this point in the evolution of engineering and technology education to examine the interface between the disciplines, the areas of commonality, the areas of difference, and the connections to other academic disciplines. Recognizing their similarities can strengthen the engineering and technology education communities and yet their differences can distinguish the importance of both disciplines (p. 253).

PROMINENT NATIONWIDE PRE-ENGINEERING PROGRAMS

A variety of pre-engineering programs have surfaced in the last 10 – 20 years, some of which developed in states such as Virginia and Louisiana, while others have been developed by endowments and professional organizations around the country. State developed programs often include curriculum which is designed to incorporate physics and engineering concepts (Sutter, 1998, p. 13). Sutter (1998) noted that these courses integrated a variety of projects that encouraged teamwork, innovation, problem solving, and critical thinking. These courses also incorporated a variety of laboratories and simulations which are used to further convey engineering concepts that may be abstract in nature. For example: pre-engineering labs included topics such as engineering drawing and design, pulley systems, structure design, beam analysis, and electronic circuit design, among others. Simulations were primarily computer-based and were used to "introduce and reinforce physics and engineering concepts, to assist in solving physics and engineering word problems, and to give students the opportunity to use *what if* scenarios" (Sutter, 1998, p. 13). Assessment for state-designed pre-engineering courses included both performance and cognitive assessment. Cognitive assessments such as content tests and student portfolios were utilized but Sutter (1998) described that performance assessment was of greater concern to the teachers just as engineers are ultimately responsible for the performance of their designs.

Government programs such as the National Science Foundation (NSF) have also sought to garner an interest in pre-engineering programs and have supplied grant funding to develop pre-engineering curricula and establish national centers for engineering and technology education. One such NSF funded program designed to prepare 11th and 12th

grade students for post-secondary education in engineering and similar fields is Project Probase (Wyse-Fisher, Daugherty, Satchwell, & Custer, 2005). Although Project Probase is designed to foster engineering competencies as well as prepare high school juniors and seniors for college engineering courses, the authors stress that technological literacy is at the forefront of the curriculum design and the content is presented in a constructivist/problem solving fashion. Project Probase is designed around the *Designed World* standards of STL which encompass seven different technological arenas. Eight learning units encompass these seven technological arenas and each unit is designed to provide 40 hours of instructional time. Students work in cooperative teams to determine and research relevant engineering concepts and principles related to the design challenge they are presented within the unit. After the initial research phase is completed, students are better able to conceptualize the design problem. Learning-cycle strategies promote the design conceptualization and also build student knowledge through the four phases of learning including: exploration, reflection, engagement, and expansion. These phases align with ITEA's *Engineering by Design*™ (EbD™) curriculum model for delivering technological literacy for students in K-12 education.

The *Engineering by Design*™ curriculum model was developed by the International Technology Education Association's (ITEA) Center to Advance the Teaching of Technology and Science (CATTS). The goal of the program is to create consistent instruction of and delivery of K-12 standards-based technology education curricula across the United States (Burke, 2006). Although it is a K-12 curriculum model which focuses primarily on technological literacy, EbD™ integrates other government funded curriculum projects such as Project ProBase for high school juniors and seniors as well as I^3 – Invention, Innovation, and Inquiry for fifth and sixth graders (Burke, 2006). These funded projects, along with the CATTS staff who developed many other integrated standards-based instructional courses suited for a variety of different age groups have merged to create a nationally recognized model program for integrating engineering and design concepts into technology education classes.

As this program is exemplary in design, primary criticisms with the program begin with developing a skilled teaching force with the knowledge and ability to teach these engineering design concepts in technology education classrooms. To counter this claim, another NSF funded initiative by the National Center for Engineering and Technology Education (NCETE) was developed to help strengthen the nation's capacity to deliver effective engineering and technology education in K-12 schools (Hailey, Ereckson, Becker, & Thomas, 2005). Foreshadowing the large number of educators expected to retire in the near future and the growing number of teachers not prepared to teach STEM concepts, NSF created the Centers for Learning and Teaching (CLT) program to help combat these issues. Although there are 17 CLTs located around the United States, NCETE is the only center whose goal is to link engineering and technology education faculty to build collaborative partnerships within both professions. NCETE has four primary goals which include:

1. Building a community of researchers and leaders to conduct research in emerging engineering and technology education areas;
2. Creating a body of research that improves the understanding of learning and teaching of engineering and technology subjects;

3. Preparing technology education teachers at the B.S. and M.S. level who can infuse engineering design into the curriculum; and
4. Increasing the number and diversity in the pathway of students selecting engineering, science, mathematics, and technology careers (p. 23).

To help accomplish these goals, NCETE has partnered with nine colleges and universities across the country, and with three professional societies.

Perhaps there is not a more well known program for teaching pre-engineering concepts to middle and high schools students while integrating, science, mathematics, and technology standards than Project Lead the Way® (PLTW®). Funded by the Charitable Venture Foundation located in Clifton Park, NY, PLTW® was designed to increase the number and quality of engineers and engineering technologists by providing:

- A fully developed curriculum for high schools;
- A middle grades technology curriculum;
- Extensive training for teachers;
- Training for high school counselors;
- Access to affordable equipment; and
- College-level certification and course credit (Hughes, 2006; SREB, 2001).

High Schools That Work (HSTW) and PLTW® partnered in 1999 to create a high school pre-engineering pathway which encompassed engineering design concepts with the rigor of high-level mathematics and science classes to adequately prepare students for engineering courses at the post-secondary level (Bottoms & Anthony, 2005). To accomplish this, PLTW® recommends a high school curriculum with four credits in college-preparatory English, four credits in college-preparatory mathematics, four credits in lab-based college-preparatory science, and three credits in college-preparatory social studies in addition to the required PLTW® courses (SREB, 2001).

Although PLTW® course offerings change occasionally, there are three required courses which must be taken in order to enroll in the other specialized course offerings. Principles of Engineering (POE), Introduction to Engineering Design (IED), and Digital Electronics (DE) comprise the core courses of the PLTW® curriculum. Other courses such as Computer Integrated Manufacturing, Biotechnical Engineering, Aerospace Engineering, and Civil Engineering and Architecture are optional courses. The POE course provides an introduction to engineering design and problem solving based on real-world engineering problems (Bottoms & Anthony, 2005). This course also discusses social and political consequences of engineering design and provides hands-on activities. The IED course utilizes computer simulation and design software packages to produce, analyze, and evaluate engineering designs. Digital Electronics, just as the name suggests, integrates digital logic and circuit design into engineering design problems. With so many course offerings, it is not surprising that national organizations like the National Academy of Engineering and the National Academies' Institute of Medicine recommend PLTW® as a way to address the shortage of high-tech workers (Hughes, 2006).

Although most proponents of PLTW® (Hughes, 2006; Rogers, 2008; Cech, 2007; Bottoms & Anthony, 2005) see it as a model program for pre-engineering and a way to increase the numbers of engineers and engineering technologists jobs in the United States, some believe that PLTW's® original goal was to reform technology education programs throughout the country (Blais & Adelson, 1998). Although PLTW® founder's original focus for what the program would be ten years ago might have changed as to what the program is today, studies (Rogers, 2005; Rogers, 2006; Bottoms & Anthony, 2005; SREB, 2001) have shown that the program has grown in the number of schools offering the program and the effectiveness of the curriculum has increased.

Bottoms and Anthony's (2005) study focused on whether the PLTW® program resulted in students with higher quality learning experiences and higher achievement when compared to other students in the HSTW network. To answer their research questions, Bottoms and Anthony (2005) analyzed the 2004 HSTW assessment and student survey and found 274 students in the HSTW network that had completed at least two PLTW® courses and randomly compared their scores to 274 other career/technical education students. From their analysis, five key findings were reported:

- When PLTW® students are compared to similar students from comparable career/technical fields, PLTW® students have significantly higher achievement in mathematics on a NAEP-referenced assessment;
- When PLTW® students are compared to similar students across all career/technical fields, PLTW® students have significantly higher achievement in reading, mathematics, and science on a NAEP-referenced assessment;
- When PLTW® students are compared to similar students in comparable fields of study and to similar students drawn from all career/technical fields, PLTW® students complete significantly more higher-level mathematics and science courses;
- Significantly more PLTW® students were enrolled in classes that engage them in reading and writing across the curriculum; and in using real-world

problems, technology, and group work to advance mathematics and science achievement; and

- Significantly more PLTW® students experience career/technical classes that required students to use academic knowledge and skills to complete project assignments (Bottoms & Anthony, 2005, p. 3).

Rogers' (2006) study measured the effectiveness on PLTW® curricula in developing pre-engineering competencies as perceived by Indiana teachers. His study was two-fold: 1) determine if high school teachers perceive PLTW® learning activities as effective in developing pre-engineering competencies for their students, and 2) find any differences between high school teachers' perceptions regarding the effectiveness of various PLTW® curricula in developing high school students' pre-engineering competencies. In his results, Rogers (2006) found that the PLTW® curriculum were perceived by teachers as being very effective (M = 4.50 or higher) for developing over half of the 14 pre-engineering competencies surveyed (p. 70). Additionally, Rogers (2006) noted that all 14 pre-engineering competencies surveyed were at 4.0 or higher in regard to PLTW® curricula being utilized to develop high school pre-engineering competencies. Rogers' (2006) study was found to support Bottoms and Anthony's (2005) study, at least in the state of Indiana where Rogers' study was carried out. He found PLTW® students were receiving effective high school instruction based on effective curriculum and engaging learning activities.

Although both Rogers' (2005) and Bottoms and Anthony's (2005) research were different in scope and population, both showed effectiveness, be it in the perception of teachers using PLTW® curricula to determine pre-engineering competencies or through norm-referenced NAEP assessments of comparing students who have taken PLTW® courses, as opposed to those students who have not. Additionally, PLTW® has received numerous recognitions and awards for its problem solving and design curriculum focus (Rogers, 2008). Because of these reasons, Rogers (2008 in Custer & Ereckson, 2008) and others believe that "PLTW® is the national linkage between technology education and engineering" (p. 227) and states that "the technology education field must not view PLTW® as a separate discipline [but] should be viewed as a trade name for the pre-engineering curricular content offered [in] technology education" (p. 228). However, Wright (2006) in and others have some philosophical differences with Rogers' sentiment to view PLTW® as a "trade name" for secondary technology education, although he personally finds no fault with strengthening the pipeline into post-secondary engineering programs by stating:

> If students choose to go into engineering as a profession as a result of engineering experiences in technology education, great, but our [technology education's] purpose is to provide an authentic, meaningful context of learning for all students (p. 6).

As noted in this section, there are a variety of studies which have strove to determine the perception and usefulness of the PLTW® curriculum as a formidable program to teach pre-engineering concepts. Bottoms and Anthony (2005) and Rogers (2005/2006) research all suggest that PLTW® is indeed an effective pre-engineering program for students interested in engineering and engineering-related careers.

ITEA/GALLUP POLL CONSTURCTION AND HISTORY

The *ITEA/Gallup Poll* was originally designed to research American's knowledge of and attitudes about technological literacy (Rose & Dugger, 2002). Based on the work and support from ITEA, NSF, and the National Aeronautics and Space Administration (NASA), and their resulting publication, *Standards for Technological Literacy: Content for the Study of Technology* (STL) (2000), the *ITEA/Gallup Poll* sought "to determine if the public's perception of what technology is and what should be taught is congruent with the opinions of national experts in the fields of technology, engineering, and science" (Rose & Dugger, 2002, p. 1). It is important to stress that the *ITEA/Gallup Poll* (2001/2004) are opinionated surveys which measure respondent's perceptions of the information presented. The *ITEA/Gallup Poll* was first conducted in 2001 and again in 2004. Figure 8 illustrates the correlation between the 2001 *ITEA/Gallup Poll* survey items and STL and Figure 9 denotes the correlation between the 2004 poll and STL. Figures 8 and 9 show the saturation of STL throughout both polls. The 2001 poll included survey items which reflected all but two of STL (Standards 14 and 19). The 2004 poll survey items as shown in Figure 9 reflects all 20 standards.

The 2001 *ITEA/Gallup Poll* survey encompassed 17 questions from three different categories including: understanding of technology (5 questions), attitude toward technology (6 questions), and technology and education (6 questions). Additionally, standard demographic information was asked of the respondents. A sample of telephone owning households in the United States was selected for the survey. Random digit dialing was used to insure inclusion of both listed and unlisted numbers. Households also had to have at least one person eighteen or older to be interviewed. One thousand interviews were completed by June 25, 2001, and their margin of error is within four percentage points with a confidence level of 95%.

2001 ITEA/Gallup Poll Survey Item Crosswalk with ITEA Standards for Technological Literacy

ITEA Standards for Technological Literacy: Content for the Study of Technology ITEA, 2000/2002

2001 ITEA/Gallup Poll Survey Items

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	X	X																		
2	X	X																		
3	X	X	X																	
4								X	X											
5						X						X								
6			X			X														
7a				X									X							
7b	X												X							
7c			X										X							
7d			X										X							
7e				X									X							
8				X																
9a				X		X														X
9b				X	X	X												X		
9c				X	X	X												X		
9d				X		X									X					
10a												X				X				
10b												X				X	X			
10c												X					X			
10d												X				X				X
10e												X				X				
11a													X			X				
11b													X				X			
11c													X			X		X		
11d													X			X				
12				X		X														
13	X	X		X																
14			X				X													
15																				
16a			X																	
16b										X	X									
16c							X	X												
16d										X		X								
16e							X			X			X							
17																				

Figure 8. 2001 ITEA/Gallup Poll Crosswalk with ITEA's STL.

Three major conclusions were drawn from Rose and Dugger's (2001) study which were:

- The American public is virtually unanimous in regarding the development of technological literacy as an important goal for people at all levels;
- Many Americans view technology narrowly as mostly being computers and the internet; and

- There is near total consensus in the public sampled that schools should include the study of technology in the curriculum (Rose & Dugger, 2002, p. 1).

2004 ITEA/Gallup Poll Survey Item Crosswalk with ITEA Standards for Technological Literacy

ITEA Standards for Technological Literacy: Content for the Study of Technology ITEA, 2000/2002

2004 ITEA/Gallup Poll Survey Items

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	X	X																		
2	X	X																		
3			X			X														
4a					X							X								
4b										X		X								
4c												X					X			
4d									X		X									
4e																				
4f										X		X				X				
5a				X								X	X							
5b			X										X							
5c	X												X							
5d			X										X							
6a	X	X					X													
6b	X	X			X															
6c								X	X											
7a														X						
7b													X							
7c																	X			
7d																X		X		
8a															X					
8b																			X	
8c																				X
8d																		X		
9a																			X	
9b																				
9c																				X
9d																		X		
10				X	X	X									X			X		X
11				X	X	X									X			X		X
12	X	X		X																
13a	X	X																		
13b				X																
13c					X															
13d			X																	
13e	X	X											X							
14				X		X														
15																				

Figure 9. 2004 ITEA/Gallup Poll Crosswalk with ITEA's STL.

ITEA/GALLUP POLL SURVEY INTREPETATIONS

Starkweather (2002) further researched the *ITEA/Gallup Poll* (2001) in order to interpret what the general public thought about technology teaching. He noted that leaders in the technology education profession realize that since technology is always evolving, technology teaching should likewise evolve with the creation and development of newer technologies. Unfortunately, he describes that stagnation is all too common in the field of education and technology education is rather unique in regards to other academic subjects as the technology discipline requires "capturing innovation" to truly succeed as an academic discipline. He also described that just during the last decade, technology teaching has evolved perhaps more than during any decade prior mainly due to the adoption of STL as well as the extensive use of computers and other information technologies. Starkweather (2002) notes that historically, technology education had not been valued as highly as that of science, mathematics, or engineering and the *ITEA/Gallup Poll* (2001) was very bold in its design and effort because of the possible negative ramifications that could surface by asking such noteworthy questions about technology and technology teaching.

Fortunately, Starkweather (2002) found the results of the study complimentary and somewhat aligned with engineering and technology professional's views of technology and technological literacy. Moreover, where conclusions were generalized by the public, such as the public's belief that technology does matter and the public wants well-informed decision-makers, he described that even though data from the public primarily equates technology as being computers and the internet, the idea that they want the education system to produce these informed decision-makers clearly aids in promoting technology education. To promote the public's belief on this idea, and to advance the field of technology, Starkweather (2002) states that the profession must "clear up confusing terminology and become a solid core subject in the school curriculum [that] reflects technological literacy" (p. 33).

SECOND INSTALLMENT OF THE ITEA/GALLUP POLL

The second *ITEA/Gallup Poll* conducted in 2004 was very similar to the first poll insomuch as several items from the 2001 poll were repeated in the 2004 poll to aid in demonstrating validity (Rose, Gallup, Dugger, & Starkweather, 2004). To further demonstrate validity, three findings are presented below.

- Approximately three-fourths of those questioned in 2001 expressed the belief that having people develop the ability to understand and use technology was important. That number remains the same;
- Two-thirds of the respondents to the first survey indicated that the first thing that came to mind when they heard the word "technology" was computers. Two-thirds of the 2004 survey respondents agree; and
- Percentages that fall in the 90th percentile in both polls expressed a preference for reacting to shortages in technology experts by taking steps to train them in our own schools. That preference remains in the same percentile range (Rose, Gallup, Dugger, & Starkweather, 2004, p. 2).

Similarities in some of the items as well as validity between respondent findings illustrate the commonalities between the 2001 and 2004 *ITEA/Gallup Polls*. The primary differences between the polls lie in the information gained from the 2001 poll on the perception of the importance of technology to the public which was over 98%. Due to the large percentage, it was deemed unnecessary to focus on how technology is important to the public, but rather to determine to what extent does being technologically literate apply to the general public. This research was conducted by categorizing questions discussing the following topics: the impact of technology on our daily lives and on the world around us, the knowledge people desire and already contain regarding technology, and the decisions people make regarding technology in public education. Similar to the 2001 study, standard demographic questions were asked for further data analysis.

The three main conclusions identified in the 2001 study further supported and reinforced in the 2004 study and are listed below:

- The public understands the importance of technology in our everyday lives and understands and supports the need for maximizing technological literacy;
- There is a definitional difference in which the public thinks first of computers when technology is mentioned, while experts in the field assign the work a meaning that encompasses almost everything we do in our lives;
- The public wants and expects the development of technological literacy to be a priority for K-12 schools; and
- Men and women are in general agreement on the importance of being able to understand and use technology and the need to include technological literacy as a part of the school's curriculum (Rose, Gallup, Dugger, & Starkweather, 2004, p. 11).

Both the 2001 and 2004 *ITEA/Gallup Polls* help to provide insight into people's understanding and perceptions regarding technology. The three major conclusions drawn from the 2001 study and the four major conclusions derived from the 2004 study support this statement. Additionally, data suggest that the general public views technology as neither good nor bad, but the results of technology can be both good and bad. Furthermore, these polls have shown that people support infusing technology in K-12 education. Optimistically, technology educators will deduce these conclusions and further data to foster greater support for the discipline of technology education and its impetus, technological literacy.

Since the *ITEA/Gallup Poll* (2004), researchers (Volk & Dugger, 2005) have utilized the poll to determine if parallels of technology perception exist between the United States public and other countries, similar to the PATT research conducted during the 1980s and 1990s. It should be noted however, that even though the *ITEA/Gallup Poll* (2001/2004) has began to transcend into international research agendas just as PATT did, the intended research goals differentiate between the two initiatives. The PATT instrument was designed to assess people's attitudes toward technology, whereas the *ITEA/Gallup Poll* (2001/2004) was STL-based and designed to measure perception of technology and technological literacy (Dugger, personal communication, February 10, 2009).

SUMMARY

This chapter has sought to review and describe relevant history, research, and variables which pertain to this study. This chapter was divided into three sections including: technological literacy, pre-engineering, and the *ITEA/Gallup Polls*. Within the technological literacy section, a brief history of technology education and technological literacy were defined, as well as an explanation for the need for a technologically literate society, and ways to assess technological literacy. In the pre-engineering section, a concise history and description of pre-engineering was presented along with subsections which discussed the inclusion of engineering content in technology education courses. Additionally, prominent nationwide pre-engineering education programs were discussed giving distinctive recognition to the Project Lead the Way® pre-engineering curriculum. This chapter concluded with perspectives on the history, construction, validation, and interpretation of the *ITEA/Gallup Polls* developed to assess the public's views on technology and technological literacy.

CHAPTER III

METHODS AND PROCEDURES

This study compared high school student's perceptions of technology and technological literacy to those perceptions of the general public. The student population in question consisted of three subgroups: students enrolled in a standards-based technology education course, students enrolled in a Project Lead the Way® (PLTW®) *Principles of Engineering* pre-engineering course, and students enrolled in a general education course (language arts, mathematics, or science). All students were enrolled in public education schools in the state of North Carolina. In this chapter, the research methods and procedures are established. Also, the research questions are presented with information on population, sample, instrumentation, and data collection procedures. Finally, statistical analysis procedures used in this study are presented.

DESIGN OF STUDY

This research is a descriptive study. Descriptive studies, according to Fraenkel and Wallen (2003) "describe a given state of affairs fully and carefully as possible" (p. 15). The design of this study allowed the researcher to compare student's understandings and perceptions of technology with existing adult's perceptions of technology data collected from ITEA's 2001 and 2004 *ITEA/Gallup Poll* studies. The student population in question consisted of three subgroups: students enrolled the *Fundamentals of Technology* technology education course, students enrolled in a PLTW® *Principles of Engineering* pre-engineering course, and students enrolled in a general education course (language arts, mathematics, or science). In addition, each student group's perceptions of technology were compared to one another to determine differences within each group.

The *Fundamentals of Technology* course is a course based on STL whereas the Project Lead the Way® *Principles of Engineering* course is designed as a pre-engineering course. Additionally, a group of students not enrolled in either the PLTW® or technology education course were assessed on their perceptions of technology. To describe the student's perceptions of technology in each of the three groups, the study utilized convenience sampling, a demographic questionnaire, the *ITEA/Gallup Poll* (2001/2004) instrument, and statistical tests to determine significant differences between group means. It should be noted that both the 2001 and 2004 *ITEA/Gallup Poll* surveys incorporated a 4-point Likert scale for each survey item in order to determine means and perform relevant statistical tests (ITEA, 2001; ITEA, 2004b). The same 4-point scale was utilized during this study to aid in the investigation of a possible correlation between the prior ITEA (2001/2004) studies and the populations sampled. Additionally, the students' perceptions of technology were described and related to the courses they completed.

POPULATION AND SAMPLE

Participants for this research study were convenience sampled from the North Carolina Department of Public Instruction's (NCDPI) technology education program and PLTW® program database. Convenience sampling methodology was used due to the pilot testing of the instrument with high school students. The NCDPI database contained the entire population (N=125) of the high school technology education teachers in the state who taught the *Fundamentals of Technology* course as well as the entire population (N=35) of North Carolina high school PLTW® programs. Fraenkel and Wallen (2003) define a convenience sample as "a group of individuals who are conveniently available for study" (p. 103). Nine PLTW®, 10 technology education, and 10 general education teachers agreed to participate in the study for a total of 29 classes.

INSTRUMENTATION

A demographic questionnaire and the *ITEA/Gallup Poll* instrument were used to collect data for this study. The demographic questionnaire was designed to integrate with the *ITEA/Gallup Polls* (2001/2004) and collected information concerning each student's gender, ethnicity, general questions about which mathematics and science courses they have taken or are currently enrolled, a question asking how many technology/engineering related courses they have taken, and a way to identify which class they were completing the questionnaire. The demographic data were used to show similarities/differences among gender, mathematics and science backgrounds, technology/engineering backgrounds, and ethnicity. The combined instrument and demographic questionnaire was redesigned to be used in an online environment so teachers could take students to a computer laboratory and have them login into the online survey system and administer the survey.

Both *ITEA/Gallup Polls* (2001/2004) were developed in collaboration with the International Technology Education Association (ITEA) and the Gallup Organization. The poll's original purpose was to determine the United States public's perceptions of technology and technological literacy (Rose & Dugger, 2002). It is important to note however, that the *ITEA/Gallup Polls* (2001/2004) are opinion polls that measure perception and general reactions to particular terms, ideas, proposals, and/or events. The instrument was well grounded in STL and several survey items directly reflect STL.

Moreover, the polls included a series of questions that focused on technology and technological literacy concepts.

The *ITEA/Gallup Polls* (2001/2004) as well as the demographic questionnaire were combined and reformatted to fit the framework of the online survey management system. The reason this was done was two-fold: 1) take advantage of the online tools survey management systems incorporate, and 2) allows teachers to administer the survey to their students with as little effort as possible. Also, by having students complete the survey online, teachers would not be responsible for having to package the results of the survey and mail them back to the researcher for data analysis and synthesis. The survey instrument used for this study is found in Appendix A.

INSTRUMENTATION VALIDITY

Fraenkel and Wallen (2003) defined validity as "the degree to which correct inferences can be made based on results from an instrument" (p. 158). They went on to cite that the validity of a research study does not only rely on the instrument, but validity is also determined through the process that the instrument is used as well as through the characteristics of the group being studied. Criterion-referenced instruments, according to Fraenkel and Wallen (2003) are instruments that specify particular goals or criterion students are expected to achieve. The *ITEA/Gallup Polls* (2001/2004) serve as criterion-referenced instruments as it aims to determine students' perception of technology and technological literacy in three different groups of students.

The content validity of the *ITEA/Gallup Polls (2001/2004)* have been established through the research of Rose and Dugger (2002) and Rose, Gallup, Dugger, and Starkweather (2004). Both research projects were designed to reveal what Americans think about technology and used STL as a foundation for the construction and validity of the instrument since STL was developed to standardize the concepts taught in the study of technology (ITEA, 2000/2002). Moreover, a majority of STL is incorporated into the instrument design to accurately assess the public's perceptions of technology (Dugger, personal communication, November, 20, 2008). Appendix A includes each survey item from both the 2001 and 2004 editions of the *ITEA/Gallup Poll* and their corresponding survey instrument listing order.

INSTRUMENTATION RELIABILTY

Reliability, according to Fraenkel and Wallen (2003), "refers to the consistency of scores obtained and how consistent they are for each individual from one administration of an instrument to another and from one set of items to another" (p. 165). The reliability of the *ITEA/Gallup Poll* has been established through both the administration of the instrument and the similar results retained.

Reliability was evident during the administration of both the 2001 and 2004 *ITEA/Gallup Polls*. In both studies, telephone-owning households were selected for the survey and random digit telephone dialing techniques were used to insure the inclusion of both listed and unlisted numbers. Also, within each household, only one man or woman eighteen years or older was surveyed. In both years, the survey was conducted over a three-month timeframe. After the surveys were collected, it was determined that both studies had 95% confidence that the error attributable to sampling and other random effects could be plus or minus four percent (Rose & Dugger, 2002; Rose, Gallup, Dugger, & Starkweather, 2004). Perhaps the only surprising difference in the administration of both polls was that the 2001 study surveyed 1000 respondents whereas the 2004 study surveyed 800 respondents.

Another aspect of instrument reliability that was attained from the *ITEA/Gallup Polls* (2001/2004) was through the similar results reported even though there was a three-year time difference between the 2001 and 2004 polls. The three major conclusions reported from the 2001 poll were almost verbatim to those of the 2004 poll. Both studies had slightly different agendas. For instance, the 2001 poll was designed to explore the public's view of technology, what it is, and its continuing impact on society, whereas the 2004 poll was designed to build on the 2001 study by adding to, reinforcing, and augmenting the understandings gained from the prior study. It is apparent however, that even though the 2001 and 2004 polls had differing agendas, the three major conclusions from the 2001 poll were only validated and reinforced with data from the 2004 study. In addition, Rose, Gallup, Dugger, and Starkweather (2004) revised the first study's conclusions incorporating three more conclusions from which the cumulative weight of the two studies justify the additional conclusions.

DATA COLLECTION

A convenience sample (n=10) from the entire population of North Carolina's *Fundamentals of Technology* course teachers (N=125) and a sample (n=9) was drawn from the entire population of North Carolina's PLTW® (N=35) programs. The initial mailing, conducted on Monday, April 20, 2009, included a cover letter explaining the study to the teachers, parent consent forms, student participation forms, a reference copy of the survey including specific demographic information, and a combined version of both the 2001 and 2004 *ITEA/Gallup Polls*. A follow-up email reminder was sent to the teachers reminding them to have their students complete the survey after the third week of the initial mailing. The follow-up mailing served as both a courteous reminder and a thank you for those teachers who have already had their students complete the survey.

It should be noted that the demographic data collected were very generalized and the data collected would not allow users to identify students based on their responses. Because of this action, the issue of student confidentiality was upheld. Additionally, it should be noted that the data collected in this study were reported in aggregate form and all information collected was destroyed at the conclusion of the research.

ANALYSIS OF DATA

Data collected from the combined 2001 and 2004 *ITEA/Gallup Poll*s were analyzed using Pearson's chi-square test to assess whether the percentages for the three groups were significantly different from one another (Ott & Longnecker, 2001). Pearson's chi-square test is a statistical test whose results are evaluated by reference in the chi-square distribution. It tests the relative frequencies of occurrence in observed events in a specified frequency distribution. Student response data were compared descriptively to the 2001 and 2004 ITEA studies with adults. Descriptive comparisons were also made between each of student groups and the relative values were similar between each group's item responses. Additionally, comparisons were made between three different student groups to determine if there was a statistical significance between those groups. Students who have studied the *Fundamentals of Technology* course, students who have taken a PLTW® *Principles of Engineering* course, and a group of students from a general education course (i.e. language arts, mathematics, or science) served as a third group. Pearson's chi-square test was used as the statistical test for all research questions. Adult perception of technology data were obtained from Rose and Dugger's (2002) and ITEA's (2004) studies and were used to compare to the students' responses to that of the adults. Research questions, according to Fraenkel and Wallen (2003), "involve areas of concern to researchers, conditions they want to improve, difficulties they want to eliminate, questions for which they seek answers" (p. 28). The purpose of research questioning in this study sought to determine if the true mean perceptions differed among the student groups tested and to determine if the student's perceptions of technology differed from the adult's perceptions of technology. Descriptive statistics were used to summarize the data in each group.

The demographic information collected from each group was synthesized in order to develop commonalities and differences between the student groups. Gender and ethnicity demographics were collected in order to observe differences in perception of technology utilizing these demographics in both mutual and exclusive manners. The general questions addressing the various mathematics, science, and technology/engineering courses students aided in determining commonalities and/or differences between each group's enrollment in the various courses and their perceptions of technology. The demographic information collected in this study was reported only in summary form to better illustrate the sample.

SUMMARY

Research participants were selected and categorized according to the type of course they had/had not taken in order to determine the proper response variables identified within each research question. The research questions were tested using Pearson's chi-square. All calculations were performed using Microsoft Excel and SAS statistical analysis computer software. Additionally, student response data collected in this study was descriptively analyzed with the adult response data from the 2001 and 2004 *ITEA/Gallup Polls*.

The research methods and procedures of this study were established in this chapter along with information regarding the population and sample of each student group to better illustrate the sample acquired. Data collection procedures and statistical analysis procedures were also presented in the chapter.

The findings of this study are presented in Chapter IV. Statistical tests on the collected data are performed and discussed in relation to the research questions.

CHAPTER IV

FINDINGS

This study compared high school student's perceptions of technology and technological literacy to those perceptions of the general public. The student population in question consisted of three subgroups: students enrolled in a standards-based technology education course, students enrolled in a Project Lead the Way® (PLTW®) *Principles of Engineering* pre-engineering course, and students enrolled in a general education course (language arts, mathematics, or science) for further student group analysis. This study is important due to the growing trend nationwide of technology education programs being replaced by pre-engineering courses and because of this trend, it is necessary to determine if there is a significant difference in student perceptions of technology from students who enroll and take technology education courses, Project Lead the Way® pre-engineering courses, as well as a group of students currently not enrolled in either program.

The design of this study allowed the researcher to compare student's understandings and perceptions of technology with existing adult's perceptions of technology data collected from ITEA's 2001 and 2004 *ITEA/Gallup Poll* studies. Five research questions steered the research design. Research Question 1 compared student response data from this study with adult respondent data from the 2001 and 2004 *ITEA/Gallup Polls*. The data were descriptively analyzed. Research Question 2 examined each of the student groups' respondent data to determine if a statistical difference existed between two or more of the student groups. Research Question 3, 4, and 5 compared student group's responses between technology education and PLTW®, PLTW® and general education, and technology education and general education respectively. Research Question 3 was the primary research question that conceptualized this study.

STUDENT SURVEY RESPONSE

Of the 29 packets mailed to teachers of all three different groups, 15 packets were returned for a response rate of 51.7%. A total of 151 students participated: 58 were enrolled in technology education classes, 23 in Project Lead the Way® classes, and 70 enrolled in general education classes. All instruments were deemed usable for the study. Technology education teachers were mailed 10 packets, five of which were returned for a response rate of 50%. Project Lead the Way® teachers were mailed nine packets, four were returned for a response rate of 44%. Ten general education teacher packets were mailed with six being returned for a response rate of 66%. Although no demographic instrument item asked respondents to identify their age and grade level, it was assumed that students were of standard high school age and grade level based on their participation in the classes in which they completed the survey. Table 1 illustrates the demographics of respondents by gender and ethnicity.

DEMOGRAPHIC ANALYSIS OF ADULTS

Demographic data from both the 2001 and 2004 editions of the *ITEA/Gallup Poll* were similar in nature. Respondents from both studies were taken from telephone households in the continental United States. One thousand people were surveyed in the 2001 study and 800 people were surveyed in the 2004 study. Both studies required the respondents to be 18 years of age or older.

The demographics for the 2001 study included 47.9% of the sample being male and 52.1% being female. The age of respondents was divided into three categories including 18-29, 30-49, 50 and older. The respondents were 20.7% in the 18-29 age group, 43.5% were in the 30-49 age group, 34.7% were in the 50 and older age group with 1.1% of the sample choosing not to disclose their age. The race demographic was categorized as white, African-American/black, and all others. Eighty-three percent of the sample classified themselves as white, 9.5% as African-American/black, and 6.9% as all others. Finally, the region of which the respondent resided was asked and divided into four categories including east, Midwest, south, and west. Of the respondents 22.8 percent listed the east as their region of residence, the Midwest had 23.6%, the south at 31.2%, and the west at 22.4%.

The demographic data for the 2004 study was comprised of 48.6% male and 51.4% female respondents. The age demographic in the 2004 study had four classifications including: 18-29, 30-49, 50-64, and 65+ age groups. Of the sample, 17.7 percent was 18-29, 41.7% were 30-49, 23.9% were 50-64, and 15.8% were 65+. Less than one percent (.9%) chose not to classify themselves within an age group. Similar to the 2001 study, over 80% (80.4%) of the respondents were white, 10.3% African-American/black, and 7.6% were all other. Lastly, the 2004 study's demographics were similar to the 2001 study in regards to categorizing the region of the United States where the respondents resided. The eastern United States respondents accounted for 22.7% of the sample, the Midwest accounted for 24%, the south accounted for 31.8%, and the west accounted for 21.5%.

Along with the standard demographic information presented in Table 1, it was decided that it would be interesting to identify how many technology and/or engineering courses students from all three groups have taken in the past, not counting the course in which they were currently taking the survey. Table 2 illustrates these findings.

Table 1

Gender and Ethnicity of Respondents

	Technology Education	PLTW®	General Education
Male	82.8% (48)	82.6% (19)	54.3% (38)
Female	17.2% (10)	17.4% (4)	45.7% (32)
African-American	19% (11)	8.7% (2)	34.3% (24)
Asian	0% (0)	13% (3)	5.7% (4)
Hispanic	5.2% (3)	8.7% (2)	4.3% (3)
White	69% (40)	69.6% (16)	51.4% (36)
Other	6.9% (4)	0% (0)	4.3% (3)

It is interesting to note that for the technology education and PLTW® groups, over 34% and 30% respectively of the students have had two technology and/or engineering courses prior to the course they were currently enrolled. Another interesting finding was the near even distribution of general education students between each of the four selections. Of the 70 general education student respondents, 19 students noted that they had never taken a technology and/or engineering class. In the remaining categories (1, 2, 3 or more), the distribution of students were all equal (17).

Table 2

Technology and/or Engineering Courses Respondents Have taken Previously not Including the Course They Are Currently Taking the Instrument.

Technology and/or Engineering Course	0	1	2	3 or more
Technology Ed (n=58)	20.7% (12)	27.6% (16)	34.5% (20)	17.2% (10)
PLTW®(n=23)	26.1% (6)	26.1% (6)	30.4% (7)	17.4% (4)
General Ed (n=70)	27.1% (19)	24.3% (17)	24.3% (17)	24.3% (17)

It was also determined that as part of the instrument's demographic information, it would be interesting to identify what mathematics and science courses the respondents had taken or were currently taking. Table 3 illustrates the mathematics courses the respondents had taken or were currently taking, and Table 4 illustrates the science courses the respondents had taken or were currently taking.

Table 3 illustrates that in lower-level mathematics classes, such as Algebra 1 and Geometry, 60% or greater percentage of students from each of the groups were either currently enrolled or have taken those courses. In the higher-level mathematics classes however (Algebra 2, Pre-Calculus, Calculus), the groups begin to differentiate. For example, only half (50%) of technology education students have taken or are currently enrolled in an Algebra 2 course, whereas almost two-thirds (64.3%) of general education students and nearly three-fourths (73.9%) of PLTW® students have taken or are currently enrolled in an Algebra 2 course. Additionally, over one third of PLTW® students (34.8%) have taken Pre-Calculus, whereas only 15.5% and 22.9% of technology education and general education students respectively have taken or are currently taking Pre-Calculus. From the data, it is apparent that PLTW® students have a stronger background in higher-level mathematics than either of the other student groups in regards to this study's sample. It should be noted that the PLTW® and technology education classes are primarily taken during the student's freshman and sophomore years. Due to the apparent variety of mathematics courses general education students had taken, the general education students as a whole, were older than the other student respondents.

Table 3

Mathematics Courses Respondent's Were Currently Enrolled or Had Taken Previously

Group	Algebra 1	Algebra 2	Geometry	Pre-Calculus	Calculus
Technology Ed (n=58)	100% (58)	50% (29)	60.3% (35)	15.5% (9)	1.7% (1)
PLTW® (n=23)	95.7% (22)	73.9% (17)	91.3% (21)	34.8% (8)	8.7% (2)
General Ed (n=70)	98.6% (69)	64.3% (45)	80% (56)	22.9% (16)	5.7% (4)

Table 4 illustrates that there is nearly an even distribution between the three student groups in regard to students who had taken or were currently taking both Physical Science and Biology, both of which are considered fundamental science courses. For instance, 69%, 65.2%, and 61.4% of technology education, PLTW®, and general education course student respondents had taken or were currently enrolled in a Physical Science class, respectively. Similarly, 75.9%, 73.9%, and 75.7% of technology education, PLTW®, and general education course student respondents have taken or are currently enrolled in a Biology course, respectively. In higher-level science courses, such as Chemistry and Physics, the PLTW® student group has a greater percentage than the other two groups. It should be noted however, that PLTW® (52.2%) and general education (47.1%) students have similar percentages in Chemistry, whereas only 19% of technology education student respondents have taken or are currently enrolled in the course.

Table 4

Science Courses Respondent's Were Currently Enrolled or Had Taken Previously

Group	Physical Science	Biology	Chemistry	Physics
Technology Ed (n=58)	69% (40)	75.9% (44)	19% (11)	13.8% (8)
PLTW® (n=23)	65.2% (15)	73.9% (17)	52.2% (12)	26.1% (6)
General Ed (n=70)	61.4% (43)	75.7% (53)	47.1% (33)	14.3% (10)

ANALYSIS OF THE RESEARCH QUESTIONS

This study investigated five research questions. Research Question 1 sought to determine if high school students' perceptions of technology differed from adult's perceptions of technology. Research Question 1 was answered by descriptively analyzing the adult's responses from the 2001 and 2004 *ITEA/Gallup Polls* with the responses from the total number of students surveyed in this study. Research Question 2 divided the total high school student respondents into three subgroups: students enrolled in a standards-based technology education course, students enrolled in a Project Lead the Way® (PLTW®) *Principles of Engineering* pre-engineering course, and students enrolled in a general education course (language arts, mathematics, or science). Once the students were subdivided into each of the three student groups, item-specific statistical analyses were conducted to determine if there was a significant difference between any of the three student subgroups' responses to each survey item. The third, fourth, and fifth research questions sought to determine the actual item differences between pairs of student groups.

SURVEY RESULTS

This section presents a detailed analysis of each research question. There were 66 original survey items, one question (Item 13f) was not used due to a typographical error, leaving 65 usable survey items for analysis. Of those 65 usable items, eight items showed a significant difference between one or more student group's individual item responses with an alpha set at .05 using Pearson's chi-square. Five additional items showed a significant difference with alpha set at .1. Setting alpha at .1 ensured that important questions which differed among the three groups were not missed. Therefore, a total of 13 items were found to differ among the three groups.

Instrument items 9, 12, 13b, 14, 16a, 16d, 17c, 22c, and 22e correspond with the 2001 *ITEA/Gallup Poll* and items 13b, 17e, 24, 25a, and 28c correspond with the 2004 edition of the *ITEA/Gallup Poll* which account for the 13 items which showed a significant difference between two or more student groups.

The first research question sought to determine if there were differences between high school students' perceptions of technology and adults' perceptions of technology in the 2001 and 2004 editions of the *ITEA/Gallup Poll.* Table 5 descriptively compares each instrument item's response as a percentage with all students surveyed in this study along with the adult's results from the 2001 and 2004 studies. Table 5 starts with item 7 as the prior 6 items were all demographic survey items. Additionally, survey item 8 is omitted from Table 5 as item 8 asks respondents to name what they first think of when they first hear the word "technology". The data for item 8 was recorded for future use.

Table 5

Student and Adult Responses to the 2001/2004 ITEA/Gallup Poll Items

Survey Item Responses	Total Student Response	Adult Response (ITEA 2001/2004)
7) Just your opinion, how important is it for people at all levels to develop some ability to understand and use technology? Would you say it is: (2001)		
- Very important	63.56%	76%
- Somewhat important	34.4%	23%
- Not very important	0%	1%
- Not very important at all	0%	0%

Table 5 (continued)

9) I want to give you two definitions and as you tell me which more closely fits with you hear the word, "technology"?

- Computers and the internet	57.6%	63%
- Changing the natural world To satisfy human needs	39.7%	36%
- Don't know/refused	2.6%	1%

10) When you hear the word "design" in relation to technology, which one are you more likely to think of – "a creative process for solving problems" or "blueprints and drawings from which you construct something"?

- A creative process for solving problems	39.1%	41%
- Blueprints and drawings from which you construct something	57.6%	59%

11) To what extent do you consider yourself to be able to understand and use technology?

- A great extent	34.4%	28%
- Some extent	57.6%	47%
- Limited extent	4.6%	20%
- Not at all	.7%	5%
- Don't know/refused	2.6%	0%

12) Which of the following statements best describes your attitude toward the various forms of technology you use in your everyday lives?

- You don't care how it works as long as it works	15.2%	24%
- You would like to know something about how it works	79.5%	75%
- Don't know/refused	5.3%	1%

13a) Technology is a major factor in the innovations developed within a country.

- Strongly agree	71%	61%
- Mostly agree	28%	34%
- Mostly disagree	4.3%	2%
- Strongly disagree	1.7%	1%

Table 5 (continued)

13b) The results of the use of technology can be good and bad.		
- Strongly agree	66%	59%
- Mostly agree	29%	35%
- Mostly disagree	3%	3%
- Strongly disagree	2%	2%
13c) Engineering and technology are basically one and the same thing.		
- Strongly agree	9%	21%
- Mostly agree	60%	40%
- Mostly disagree	27%	27%
- Strongly disagree	4%	9%
13d) Science and technology are basically one and the same thing.		
- Strongly agree	19%	20%
- Mostly agree	38.5%	39%
- Mostly disagree	36%	27%
- Strongly disagree	6.5%	12%
13e) Technology is a small factor in everyday life.		
- Strongly agree	14.5%	17%
- Mostly agree	14.5%	24%
- Mostly disagree	22%	25%
- Strongly disagree	49%	34%
13g) Most environmental problems can be solved using technology		
- Strongly agree	16.5%	24%
- Mostly agree	53.6%	42%
- Mostly disagree	25.8%	23%
- Strongly disagree	4%	10%
13h) Design is a process that can be used to turn ideas into products.		
- Strongly agree	51.7%	68%
- Mostly agree	43.7%	29%
- Mostly disagree	3.3%	2%
- Strongly disagree	0%	1%

Table 5 (continued)

14) To which of the following do you feel technology is of the most importance and or has the greatest effect?

- Our society	70.9%	62%
- Our environment	16.6%	20%
- The individual	5.7%	17%
- Don't know/refused	3.3%	1%

15a) How much input do you think you should have about the designation of neighborhood community centers?

- Great deal	38.7%	43%
- Some	48%	47%
- Not very much	11.3%	6%
- None at all	2%	3%

15b) How much input do you think you should have about where to locate roads in your community?

- Great deal	37%	44%
- Some	47%	44%
- Not very much	12.6%	8%
- None at all	3.4%	3%

15c) How much input do you think you should have about the development of fuel efficient cars?

- Great deal	41%	37%
- Some	41%	44%
- Not very much	14%	10%
- None at all	4%	8%

15d) How much input do you think you should have about the development of genetically modified foods?

- Great deal	36%	41%
- Some	33.8%	37%
- Not very much	18.7%	10%
- None at all	11.3%	11%

16a) Yes or No – Could you explain to a friend how a flashlight works?

- Yes response	76%	90%

Table 5 (continued)

16b)	Yes or No – Could you explain to a friend how to use a credit card to get money out of an ATM?		
	- Yes response	82.8%	89%
16c)	Yes or No – Could you explain to a friend how a telephone call gets from point A to point B?		
	- Yes response	72.7%	65%
16d)	Yes or No – Could you explain to a friend how a home heating system works?		
	- Yes response	44%	70%
16e)	Yes or No – Could you explain to a friend how energy is transferred into electrical power?		
	- Yes response	48.7%	53%
17a)	True or False – Using a portable phone while in the bathtub creates the possibility of being electrocuted.		
	- Absolutely/Probably true response	69%	46%
17b)	True or False – FM radios operate free of static.		
	- Absolutely/Probably true response	25%	72%
17c)	True or False – A car operates through a series of explosions.		
	- Absolutely/Probably true response	70%	82%
17d)	True or False – A microwave heats food from the outside to the inside.		
	- Absolutely/Probably true response	64.7%	37%

Table 5 (continued)

17e)	Antibiotics kill viruses as well as bacteria.		
	- Absolutely true	24%	19%
	- Probably true	43.2%	29%
	- Probably false	13%	16%
	- Absolutely false	19.8%	35%
17f)	The Internet and the World Wide Web are the same thing.		
	- Absolutely true	48.3%	30%
	- Probably true	28.5%	42%
	- Probably false	12.6%	13%
	- Absolutely false	10.6%	11%
17g)	Fuel cells are now being used with gasoline or diesel engines to power cars.		
	- Absolutely true	32.7%	27%
	- Probably true	53.3%	50%
	- Probably false	8.7%	11%
	- Absolutely false	5.3%	5%
18)	When a national shortage of qualified people occurs in a particular area of technology, which of the following solutions would you feel is the most appropriate course of action for the U.S. to take?		
	- Bring in technologically literate people from other countries	15.9%	6%
	- Take steps through our schools to increase the number of technologically literate people in this country.	70.9%	93%
	- Don't know/refused	13.2%	1%
19)	Using the broad definition of technology as "modifying our natural world to meet human needs," do you believe the study of technology should be included in the school curriculum, or not?		
	- Yes, it should be included	86.8%	97%
20)	Should the study of technology be made part of other subjects like, science, math, and social studies, or should it be taught as a separate subject?		
	- Teach as part of other subjects	46.9%	63%
	- Teach as separate subject	51.6%	36%

Table 5 (continued)

21)	(Asked of those saying "separate subject.") Should the subject be required or optional?		
	- Required	42.6%	51%
22a)	Tell me how important it is for schools to prepare students to understand the relationship between technology, science, and mathematics.		
	- Very important	54.5%	79%
	- Fairly important	38.6%	19%
	- Not very important	5.5%	2%
	- Not at all important	0%	0%
	- Don't know/refused	1.4%	0%
22b)	Tell me how important it is for schools to prepare students about the role of people in the development and use of technology.		
	- Very important	48%	72%
	- Fairly important	45.8%	24%
	- Not very important	4.2%	3%
	- Not at all important	0%	1%
	- Don't know/refused	2%	0%
22c)	Tell me how important it is for schools to prepare students to know something about how products are designed.		
	- Very important	38%	41%
	- Fairly important	44%	45%
	- Not very important	14%	12%
	- Not important at all	1%	1%
	- Don't know/refused	3%	1%
22d)	Tell me how important it is for schools to prepare students to have the ability to select and use products.		
	- Very important	53%	66%
	- Fairly important	32%	27%
	- Not very important	11%	5%
	- Not at all important	2%	2%
	- Don't know/refused	2%	0%

Table 5 (continued)

22e)	Tell me how important it is for schools to prepare students to understand the advances and innovations in technology.		
	- Very important	51.4%	66%
	- Fairly important	34.8%	30%
	- Not very important	9.8%	4%
	- Not very important at all	1%	0%
	- Don't know/refused	3%	0%
23)	Should students be evaluated for technological literacy as part of high school graduation requirements?		
	- Yes response	41.4%	61%
	- Don't know/refused	12.4%	1%
24)	How important is it to you to know how various technologies work?		
	- Very important	44.1%	38%
	- Somewhat important	52.4%	48%
	- Not very important	2.8%	11%
	- Not important at all	.7%	3%
25a)	How important is it to you, personally, to know whether or not it is better to repair products or better to throw them away?		
	- Very important	61.4%	64%
	- Somewhat important	31.8%	29%
	- Not very important	4%	4%
	- Not very important at all	1.4%	3%
	- Don't know/refused	1.4%	0%
25b)	How important is it to you, personally, to diagnose why something doesn't work so it can be fixed?		
	- Very important	58%	62%
	- Somewhat important	34.5%	30%
	- Not very important	5%	5%
	- Not very important at all	1.4%	3%
	- Don't know/refused	1.4%	0%

Table 5 (continued)

25c) How important is it to you, personally, to know how to program a VCR or use other "thinking" products?

- Very important	36.4%	54%
- Somewhat important	40.6%	35%
- Not very important	16.8%	8%
- Not very important at all	4.2%	3%
- Don't know/refused	2%	0%

25d) How important is it to you, personally, to be able to develop solutions to a practical technological problem?

- Very important	53.5%	50%
- Somewhat important	35.4%	39%
- Not very important	7%	8%
- Not very important at all	2.1%	3%
- Don't know/refused	2.1%	0%

25e) How important is it to you, personally, to know how to fix a light switch or other household product that stops working?

- Very important	51.8%	53%
- Somewhat important	37.1%	33%
- Not very important	7%	11%
- Not very important at all	2.1%	3%
- Don't know/refused	2.1%	0%

25f) How important is it to you, personally, to know how products such as a paper stapler works?

- Very important	35.2%	28%
- Somewhat important	26.2%	36%
- Not very important	26.9%	26%
- Not very important at all	8.3%	10%
- Don't know/refused	3.5%	0%

27a) How interested are you, yourself, in the modification of plants and animals to supply food?

- Very interested	26.2%	28%
- Somewhat interested	31.7%	41%
- Not very interested	28.3%	17%
- Not interested at all	11%	14%
- Don't know/refused	2.8%	0%

Table 5 (continued)

27b) How interested are you, yourself, in robotics and other technologies in manufacturing?

- Very interested	39%	14%
- Somewhat interested	42.8%	41%
- Not very interested	12.4%	25%
- Not interested at all	4%	15%
- Don't know/refused	1.4%	0%

27c) How interested are you, yourself, in new construction methods for homes and buildings?

- Very interested	35.7%	35%
- Somewhat interested	37.8%	39%
- Not very interested	17.5%	16%
- Not interested at all	7%	10%

27d) How interested are you, yourself in space exploration?

- Very interested	36%	27%
- Somewhat interested	38.2%	37%
- Not very interested	15.3%	19%
- Not interested at all	9%	17%
- Don't know/refused	1.5%	0%

28a) How informed are you about the modification of plants and animals to supply food?

- Very informed	17.4%	8%
- Somewhat informed	39.6%	43%
- Not very informed	29.2%	32%
- Not at all informed	10.4%	17%
- Don't know/refused	3.5%	0%

28b) How informed are you about robotics and other technologies in manufacturing?

- Very informed	19%	7%
- Somewhat informed	44%	38%
- Not very informed	26.4%	36%
- Not at all informed	8.3%	19%
- Don't know/refused	2.8%	0%

Table 5 (continued)

28c) How informed are you about new construction methods for homes and buildings?

- Very informed	24.8%	14%
- Somewhat informed	38%	45%
- Not very informed	29.7%	28%
- Not at all informed	5.5%	14%
- Don't know/refused	2%	0%

28d) How informed are you about space exploration?

- Very informed	16.6%	9%
- Somewhat informed	38.6%	51%
- Not very informed	34.5%	26%
- Not at all informed	6.2%	14%
- Don't know/refused	4%	40%

29) How much influence do you think people like yourself have on decisions about such things as fuel efficiency or cars, the construction of roads in your community, and genetically modified foods?

- A great deal	20.7%	9%
- Some	41.4%	32%
- Very little	28.3%	40%
- No influence	6.2%	19%
- Don't know/refused	3.4%	0%

30) Thinking about such things as the fuel efficiency of cars, the construction or roads in your community, and genetically modified foods, how much confidence do you have in experts in these fields to make the right decisions for your community?

- A great deal	18.6%	12%
- Some	62.1%	54%
- Very little	12.4%	27%
- No influence	2.8%	6%
- Don't know/refused	4.1%	1%

31a) How important is it that high school students understand and are able to have the skills to apply technology?

- Very important	67.6%	76%
- Somewhat important	28.2%	22%
- Not very important	1.4%	1%
- Not at all important	1.4%	1%
- Don't know/refused	1.4%	0%

Table 5 (continued)

31b) How important is it that high school students understand the overall effect of technology on our society?

- Very important	60%	71%
- Somewhat important	34%	27%
- Not very important	3.5%	2%
- Not at all important	2.1%	0%
- Don't know/refused	.4%	0%

31c) How important is it that high school students understand the relationship between technology and the environment?

- Very important	50%	68%
- Somewhat important	34.3%	29%
- Not very important	7.7%	2%
- Not at all important	2.1%	1%
- Don't know/refused	1.4%	0%

31d) How important is it that high school students understand the relationship between technology and the economy?

- Very important	53%	67%
- Somewhat important	34%	30%
- Not very important	8.3%	2%
- Not at all important	3.5%	1%
- Don't know/refused	1.4%	0%

31e) How important is it that high school students be able to evaluate the pros and cons of specific technology uses?

- Very important	54.2%	58%
- Somewhat important	34%	38%
- Not very important	6.3%	4%
- Not at all important	2.1%	0%
- Don't know/refused	3.5%	0%

32) The federal government requires that students be tested in science, mathematics, and reading. In your opinion, should these tests include or not include questions to help determine how much these students understand and know about technology?

- Yes, should be included	57.2%	88%
- Don't know/refused	11.7%	1%

Research Question 2 sought to determine if there was a difference between the student groups' survey item responses. It was deemed appropriate to descriptively analyze each student groups' item responses collectively before determining statistical differences between the student groups. Table 6 descriptively analyzes survey item responses from each of the three student groups.

Table 6

Student Group Responses to the 2001/2004 ITEA/Gallup Poll Items

Survey Item Responses	Technology Education	General Education	PLTW®
7) Just your opinion, how important is it for people at all levels to develop some ability to understand and use technology? Would you say it is: (2001)			
- Very important	70.7%	58.6%	60.9%
- Somewhat important	29.3%	38.6%	0%
- Not very important	0%	0%	0%
- Not very important at all	0%	0%	4.3%
9) I want to give you two definitions and as you tell me which more closely fits with you hear the word, "technology"?			
- Computers and the internet	37.9%	68.6%	73.9%
- Changing the natural world to satisfy human needs	60.3%	28.6%	21.7%
- Don't know/refused	1.7%	2.9%	4.3%
10) When you hear the word "design" in relation to technology, which one are you more likely to think of – "a creative process for solving problems" or "blueprints and drawings from which you construct something"?			
- A creative process for solving problems	36.2%	34.3%	60.9%
- Blueprints and drawings from which you construct something	62.1%	61.4%	34.8%
- Don't know	1.7%	4.3%	4.3%

Table 6 (continued)

11) To what extent do you consider yourself to be able to understand and use technology?			
- A great extent	41.4%	28.6%	34.8%
- Some extent	51.7%	64.3%	52.2%
- Limited extent	5.2%	2.9%	8.7%
- Not at all	0%	1.4%	0%
- Don't know/refused	1.7%	2.9%	4.3%
12) Which of the following statements best describes your attitude toward the various forms of technology you use in your everyday lives?			
- You don't care how it works as long as it works	13.8%	12.9%	26.1%
- You would like to know something about how it works	86.2%	77.1%	69.6%
- Don't know/refused	0%	10%	4.3%
13a) Technology is a major factor in the innovations developed within a country.			
- Strongly agree	67.2%	72.9%	73.9%
- Mostly agree	31%	27.1%	21.7%
- Mostly disagree	0%	0%	4.3%
- Strongly disagree	1.7%	0%	0%
13b) The results of the use of technology can be good and bad.			
- Strongly agree	72.4%	69.6%	39.1%
- Mostly agree	22.4%	29%	47.8%
- Mostly disagree	1.7%	1.4%	8.7%
- Strongly disagree	3.4%	0%	4.3%
13c) Engineering and technology are basically one and the same thing.			
- Strongly agree	10.5%	7.2%	13%
- Mostly agree	61.4%	60.9%	52.2%
- Mostly disagree	24.6%	29%	26.1%
- Strongly disagree	3.5%	2.9%	8.7%

Table 6 (continued)

13d)	Science and technology are basically one and the same thing.			
	- Strongly agree	27.6%	10.4%	21.7%
	- Mostly agree	36.2%	44.8%	26.1%
	- Mostly disagree	13.8%	38.8%	43.5%
	- Strongly disagree	6.9%	6%	8.7%
13e)	Technology is a small factor in everyday life.			
	- Strongly agree	19%	15.7%	0%
	- Mostly agree	13.8%	17.1%	8.7%
	- Mostly disagree	19%	18.6%	39.1%
	- Strongly disagree	48.3%	48.6%	52.2%
13g)	Most environmental problems can be solved using technology			
	- Strongly agree	20.7%	14.3%	13%
	- Mostly agree	58.6%	51.4%	47.8%
	- Mostly disagree	17.2%	31.4%	30.4%
	- Strongly disagree	3.4%	2.9%	8.7%
13h)	Design is a process that can be used to turn ideas into products.			
	- Strongly agree	56.9%	49.3%	47.8%
	- Mostly agree	41.4%	44.9%	47.8%
	- Mostly disagree	1.7%	4.3%	4.3%
	- Strongly disagree	0%	1.4%	0%
14)	To which of the following do you feel technology is of the most importance and or has the greatest effect?			
	- Our society	70.7%	71.4%	69.6%
	- Our environment	20.7%	15.7%	8.7%
	- The individual	8.6%	5.7%	21.7%
	- Don't know/refused	0%	7.1%	0%
15a)	How much input do you think you should have about the designation of neighborhood community centers?			
	- Great deal	42.1%	41.4%	21.7%
	- Some	47.4%	42.9%	65.2%
	- Not very much	10.5%	12.9%	8.7%
	- None at all	0%	2.9%	4.3%

Table 6 (continued)

15b) How much input do you think you should have about where to locate roads in your community?			
- Great deal	43.1%	34.3%	30.4%
- Some	44.8%	50%	43.5%
- Not very much	12.1%	10%	21.7%
- None at all	0%	5.7%	4.3%
15c) How much input do you think you should have about the development of fuel efficient cars?			
- Great deal	37.9%	42.9%	43.5%
- Some	39.7%	42.9%	39.1%
- Not very much	22.4%	8.6%	8.7%
- None at all	0%	5.7%	8.7%
15d) How much input do you think you should have about the development of genetically modified foods?			
- Great deal	26.3%	44.3%	34.8%
- Some	35.1%	31.4%	39.1%
- Not very much	26.3%	14.3%	13%
- None at all	12.3%	10%	13%
16a) Yes or No – Could you explain to a friend how a flashlight works?			
- Yes response	65.5%	79.7%	91.3%
16b) Yes or No – Could you explain to a friend how to use a credit card to get money out of an ATM?			
- Yes response	75.9%	87.1%	87%
16c) Yes or No – Could you explain to a friend how a telephone call gets from point A to point B?			
- Yes response	73.7%	74.4%	65.2%
16d) Yes or No – Could you explain to a friend how a home heating system works?			
- Yes response	58.6%	32.9%	39.1%

Table 6 (continued)

16e)	Yes or No – Could you explain to a friend how energy is transferred into electrical power?			
	- Yes response	53.4%	49.3%	34.8%
17a)	True or False – Using a portable phone while in the bathtub creates the possibility of being electrocuted.			
	- Absolutely/Probably true response	70.7%	68.5%	65.2%
17b)	True or False – FM radios operate free of static.			
	- Absolutely/Probably true response	24.1%	24.3%	30.4%
17c)	True or False – A car operates through a series of explosions.			
	- Absolutely/Probably true response	70.7%	68.1%	73.9%
17d)	True or False – A microwave heats food from the outside to the inside.			
	- Absolutely/Probably true response	74.2%	58%	60.9%
17e)	Antibiotics kill viruses as well as bacteria.			
	- Absolutely true	25.9%	27.1%	8.7%
	- Probably true	48.3%	45.7%	30.4%
	- Probably false	8.6%	12.9%	21.7%
	- Absolutely false	17.2%	14.3%	39.1%
17f)	The Internet and the World Wide Web are the same thing.			
	- Absolutely true	55.2%	42.9%	47.8%
	- Probably true	19%	40%	17.4%
	- Probably false	13.8%	10%	17.4%
	- Absolutely false	12.1%	7.1%	17.4%

Table 6 (continued)

17g) Fuel cells are now being used with gasoline or diesel engines to power cars.

- Absolutely true	36.2%	30%	31.8%
- Probably true	50%	55.7%	54.5%
- Probably false	10.3%	8.6%	4.5%
- Absolutely false	3.4%	5.7%	9.1%

18) When a national shortage of qualified people occurs in a particular area of technology, which of the following solutions would you feel is the most appropriate course of action for the U.S. to take?

- Bring in technologically literate people from other countries	10.3%	18.6%	21.7%
- Take steps through our schools to increase the number of technologically literate people in this country.	72.4%	71.4%	65.2%
- Don't know/refused	17.2%	10%	13%

19) Using the broad definition of technology as "modifying our natural world to meet human needs," do you believe the study of technology should be included in the school curriculum, or not?

- Yes, it should be included	93.1%	81.4%	87%

20) Should the study of technology be made part of other subjects like, science, math, and social studies, or should it be taught as a separate subject?

- Teach as part of other subjects	52.8%	40%	50%
- Teach as separate subject	45.3%	58.2%	50%

21) (Asked of those saying "separate subject.") Should the subject be required or optional?

- Required	48%	36.4%	50%

22a) Tell me how important it is for schools to prepare students to understand the relationship between technology, science, and mathematics.

- Very important	57.4%	57.4%	39.1%
- Fairly important	35.2%	36.8%	52.2%
- Not very important	7.4%	2.9%	8.7%
- Not at all important	0%	0%	0%
- Don't know/refused	0%	2.9%	0%

Table 6 (continued)

22b) Tell me how important it is for schools to prepare students about the role of people in the development and use of technology.

- Very important	51.9%	41.8%	56.5%
- Fairly important	44.4%	47.8%	43.5%
- Not very important	3.7%	6%	0%
- Not at all important	0%	0%	0%
- Don't know/refused	0%	4.5%	0%

22c) Tell me how important it is for schools to prepare students to know something about how products are designed.

- Very important	52.8%	30.9%	26.1%
- Fairly important	39.6%	45.6%	43.5%
- Not very important	7.5%	13.2%	30.4%
- Not important at all	0%	2.9%	0%
- Don't know/refused	0%	7.4%	0%

22d) Tell me how important it is for schools to prepare students to have the ability to select and use products.

- Very important	59.3%	54.5%	34.8%
- Fairly important	25.9%	28.8%	56.5%
- Not very important	11.1%	12.1%	4.3%
- Not at all important	1.9%	1.5%	4.3%
- Don't know/refused	1.9%	3%	0%

22e) Tell me how important it is for schools to prepare students to understand the advances and innovations in technology.

- Very important	51.9%	49.3%	56.5%
- Fairly important	38.9%	37.3%	17.4%
- Not very important	7.4%	6%	26.1%
- Not very important at all	0%	1.5%	0%
- Don't know/refused	1.9%	6%	0%

23) Should students be evaluated for technological literacy as part of high school graduation requirements?

- Yes response	50%	35.3%	39.1%
- Don't know/refused	11.1%	10.3%	21.7%

Table 6 (continued)

24) How important is it to you to know how various technologies work?

- Very important	55.6%	35.3%	43.5%
- Somewhat important	38.9%	63.2%	52.2%
- Not very important	5.6%	1.5%	0%
- Not important at all	0%	0%	4.3%

25a) How important is it to you, personally, to know whether or not it is better to repair products or better to throw them away?

- Very important	68.5%	52.9%	69.6%
- Somewhat important	27.8%	39.7%	17.4%
- Not very important	3.7%	1.5%	13%
- Not very important at all	0%	2.9%	0%
- Don't know/refused	0%	2.9%	0%

25b) How important is it to you, personally, to diagnose why something doesn't work so it can be fixed?

- Very important	61.1%	55.9%	56.5%
- Somewhat important	35.2%	33.8%	34.8%
- Not very important	1.9%	5.9%	8.7%
- Not very important at all	1.9%	1.5%	0%
- Don't know/refused	0%	2.9%	0%

25c) How important is it to you, personally, to know how to program a VCR or use other "thinking" products?

- Very important	46.3%	32.4%	23.8%
- Somewhat important	33.3%	44.1%	47.6%
- Not very important	14.8%	19.1%	14.3%
- Not very important at all	5.6%	2.9%	4.8%
- Don't know/refused	0%	1.5%	9.5%

25d) How important is it to you, personally, to be able to develop solutions to a practical technological problem?

- Very important	54.7%	57.4%	39.1%
- Somewhat important	37.7%	27.9%	52.2%
- Not very important	3.8%	8.8%	8.7%
- Not very important at all	1.9%	2.9%	0%
- Don't know/refused	1.9%	2.9%	0%

Table 6 (continued)

25e) How important is it to you, personally, to know how to fix a light switch or other household product that stops working?

- Very important	53.7%	51.5%	47.8%
- Somewhat important	37%	34.8%	43.5%
- Not very important	7.4%	7.6%	4.3%
- Not very important at all	1.9%	1.5%	4.3%
- Don't know/refused	0%	4.5%	0%

25f) How important is it to you, personally, to know how products such as a paper stapler works?

- Very important	33.3%	38.2%	30.4%
- Somewhat important	31.5%	22.1%	26.1%
- Not very important	27.8%	25%	30.4%
- Not very important at all	5.6%	10.3%	8.7%
- Don't know/refused	1.9%	4.4%	4.3%

27a) How interested are you, yourself, in the modification of plants and animals to supply food?

- Very interested	27.8%	27.9%	17.4%
- Somewhat interested	35.2%	35.3%	13%
- Not very interested	27.8%	25%	39.1%
- Not interested at all	5.6%	10.3%	26.1%
- Don't know/refused	3.7%	1.5%	4.3%

27b) How interested are you, yourself, in robotics and other technologies in manufacturing?

- Very interested	30.2%	41.2%	52.2%
- Somewhat interested	52.8%	38.2%	34.8%
- Not very interested	13.2%	14.7%	4.3%
- Not interested at all	1.9%	4.4%	8.7%
- Don't know/refused	1.9%	1.5%	0%

27c) How interested are you, yourself, in new construction methods for homes and buildings?

- Very interested	43.4%	27.3%	32.4%
- Somewhat interested	37.7%	36.4%	38.2%
- Not very interested	13.2%	22.7%	19.1%
- Not interested at all	5.7%	9.1%	7.4%
- Don't know/refused	0%	2.9%	4.5%

Table 6 (continued)

27d) How interested are you, yourself in space exploration?

- Very interested	41.5%	32.4%	34.8%
- Somewhat interested	43.4%	36.8%	30.4%
- Not very interested	7.5%	20.6%	17.4%
- Not interested at all	7.5%	8.8%	13%
- Don't know/refused	0%	1.5%	4.3%

28a) How informed are you about the modification of plants and animals to supply food?

- Very informed	16.7%	17.9%	17.4%
- Somewhat informed	57.4%	29.9%	26.1%
- Not very informed	16.7%	35.8%	39.1%
- Not at all informed	7.4%	11.9%	13%
- Don't know/refused	1.9%	4.5%	4.3%

28b) How informed are you about robotics and other technologies in manufacturing?

- Very informed	24.5%	16.2%	13%
- Somewhat informed	50.9%	36.8%	47.8%
- Not very informed	15.1%	33.8%	30.4%
- Not at all informed	7.5%	10.3%	4.3%
- Don't know/refused	1.9%	2.9%	4.3%

28c) How informed are you about new construction methods for homes and buildings?

- Very informed	35.2%	19.1%	17.4%
- Somewhat informed	46.3%	30.9%	39.1%
- Not very informed	16.7%	35.3%	43.5%
- Not at all informed	0%	11.8%	0%
- Don't know/refused	1.9%	2.9%	0%

28d) How informed are you about space exploration?

- Very informed	16.7%	17.6%	13%
- Somewhat informed	48.1%	29.4%	43.5%
- Not very informed	27.8%	39.7%	34.8%
- Not at all informed	3.7%	8.8%	4.3%
- Don't know/refused	3.7%	4.4%	4.3%

Table 6 (continued)

29) How much influence do you think people like yourself have on decisions about such things as fuel efficiency or cars, the construction of roads in your community, and genetically modified foods?

- A great deal	25.9%	19.1%	13%
- Some	48.1%	35.3%	43.5%
- Very little	24.1%	30.9%	30.4%
- No influence	1.9%	8.8%	8.7%
- Don't know/refused	0%	4.9%	4.3%

30) Thinking about such things as the fuel efficiency of cars, the construction or roads in your community, and genetically modified foods, how much confidence do you have in experts in these fields to make the right decisions for your community?

- A great deal	20.4%	14.7%	26.1%
- Some	72.2%	58.8%	47.8%
- Very little	7.4%	16.2%	13%
- No influence	0%	4.4%	4.3%
- Don't know/refused	0%	5.9%	8.7%

31a) How important is it that high school students understand and are able to have the skills to apply technology?

- Very important	73.6%	67.2%	54.5%
- Somewhat important	24.5%	28.4%	36.4%
- Not very important	1.9%	1.5%	0%
- Not at all important	0%	1.5%	4.5%
- Don't know/refused	0%	1.5%	4.5%

31b) How important is it that high school students understand the overall effect of technology on our society?

- Very important	68.5%	55.2%	52.2%
- Somewhat important	27.8%	37.3%	39.1%
- Not very important	1.9%	4.5%	4.3%
- Not at all important	1.9%	1.5%	4.3%
- Don't know/refused	0%	1.5%	0%

Table 6 (continued)

31c) How important is it that high school students understand the relationship between technology and the environment?			
- Very important	53.7%	51.5%	39.1%
- Somewhat important	37%	39.4%	39.1%
- Not very important	9.3%	4.5%	13%
- Not at all important	0%	1.5%	8.7%
- Don't know/refused	0%	3%	0%
31d) How important is it that high school students understand the relationship between technology and the economy?			
- Very important	57.4%	52.2%	43.5%
- Somewhat important	33.3%	35.8%	30.4%
- Not very important	5.6%	6%	21.7%
- Not at all important	1.9%	4.5%	4.3%
- Don't know/refused	1.9%	1.5%	0%
31e) How important is it that high school students be able to evaluate the pros and cons of specific technology uses?			
- Very important	61.1%	50.7%	47.8%
- Somewhat important	29.6%	38.8%	30.4%
- Not very important	3.7%	4.5%	17.4%
- Not at all important	0%	3%	4.3%
- Don't know/refused	5.6%	3%	0%
32) The federal government requires that students be tested in science, mathematics, and reading. In your opinion, should these tests include or not include questions to help determine how much these students understand and know about technology?			
- Yes, should be included	70.4%	47.1%	56.5%
- Don't know/refused	9.3%	13.2%	13%

Research Question 2 also sought to determine if there was a statistical difference between the student group's survey item responses although the descriptive analysis of each of the student groups' item responses were relatively similar to one another. It was deemed appropriate to determine if there was a statistically significant difference between student group item responses before each student group pairing could be analyzed. Table 7 illustrates the survey instrument items and P-values calculated using Pearson's chi-square for the thirteen survey items that noted a significant difference between two or more of the student groups.

Table 7

Survey Instrument Items which Showed a Significant Difference Between Student Groups and Its P-value (p < .1)

Survey Item		P-value
9)	I want to give you two definitions and as you to tell me which more closely fits when you hear the word, "technology". Do you think of "computers and the internet", or do you think of "changing the natural world to satisfy our needs?"	.0018
12)	Which of the following statements best describes your attitude toward the various forms of technology you use in your everyday lives? (You don't care how it works as long as it works, You would like to know something about how it works, didn't know/refused)	.0659
13b)	Do you strongly agree, mostly agree, mostly disagree, or strongly disagree that the results of the use of technology can be good and bad.	.0434
14)	To which of the following do you feel technology is of the most importance and has the greatest effect? (our society, our environment, the individual, didn't know/refused)	.0594
16a)	Yes or No, could you explain how a flashlight works to a friend?	.0307
16d)	Yes or No, could you explain how a home heating system works to a friend?	.0124
17c)	True or False, a car operates through a series of explosions.	.0267
17e)	True or False, antibiotics kill viruses as well as bacteria.	.0647

Table 7 (continued)

22c)	Tell me how important is it for schools to prepare students to know how products are designed. Would you say it is very important, fairly important, not very important, or not important at all?	.0150
22e)	Tell me how important is it for schools to prepare students to have an understanding of the advances and innovations in technology. Would you say it is very important, fairly important, not very important, or not important at all?	.0890
24)	How important is it to you to know how various technologies work? Is it very important, somewhat important, not very important, not important at all?	.0287
25a)	How important is it to you personally whether it's better to repair products or better to throw them away? Is it very important, somewhat important, not very important at all, or not important at all?	.0644
28c)	Please tell me how informed you are about new construction methods for homes and buildings. Would you say you are very informed, somewhat informed, not very informed, or not informed at all?	.0079

Research Questions 3, 4, and 5 disseminated the different groups' responses into pairs in order to determine if a statistically significant difference was found among the group pairing's responses. For these research questions, it was determined that the alpha level should be .1. Further, if the p-value was less than alpha, there was a statistically significant difference between each pair of group responses.

Research Question 3 was established to determine if students who completed a *Fundamentals of Technology* course would have the same perceptions of technology as students who completed a Project Lead the Way® pre-engineering course. Seven of the thirteen survey instrument items were found to be significantly different between the group pair. The chi-square analysis of items 9 ($p = .0018$), 13b ($p = .0338$), 16a ($p = .0186$), 17e ($p = .0269$), 22c (.0148), 22e (.0681), and 28c ($p = .0079$) demonstrated that there was a significant difference in these seven survey items.

Item 9 gave two definitions of the term technology and asked participants which one of the definitions do they believe most closely fits the term. The definitions were "computers and the internet" and "changing the natural world to satisfy our needs". For students who were unsure, there was also a "don't know" option. Based on the International Technology Education Association's definition of technology, the phrase "changing the natural world to satisfy our needs" is the preferred answer. The data analysis of the item illustrated that there was a significant difference between both the technology education and PLTW® groups ($p = .0072$) as well as the technology education and general education student groups ($p = .0015$). Over half (60.3%) of the technology education students identified "changing the natural world to satisfy our needs" as their selection as compared to 21.7% of PLTW® students and 28.6% of general education students. There was no significant difference between the PLTW® student responses and the general education student responses for this item.

Item 13b asked if students strongly agree, mostly agree, mostly disagree, or strongly disagree regarding whether the results of technology can be good and bad. Of the technology education students, 94.8% either strongly agreed or mostly agreed, whereas 86.9% of PLTW® students either strongly agreed or mostly agreed with this item. The primary difference between the two groups was with the mostly disagree or strongly disagree items. Thirteen percent of the PLTW® students either mostly disagreed or strongly disagreed with the statement, while only 5.1% of the technology education students either mostly disagreed or strongly disagreed. Additionally, it should be noted that from the statistical analysis of this item, there was also a significant difference (p = .0171) between the responses of the PLTW® and the general education student groups. Another interesting fact regarding this survey item was that it was a question asked on both the 2001 and 2004 *ITEA/Gallup Polls* which helped to aid the reliability and validity of the original instrument.

Item 16a asked students to answer yes or no as to whether or not they could explain how a flashlight worked to a friend. Over 90 percent (91.3%) of PLTW® students believed they could explain how a flashlight worked, whereas only 65.5% of technology education students felt they could explain how a flashlight worked to a friend. This item was interesting in that almost 80% (79.7%) of general education students also believed they could explain how a flashlight worked to a friend which was nearly in the middle of the responses between the 65.5% of technology education students and 91.3% of PLTW® students who believed they could explain to a friend how a flashlight worked. There was also a significant difference in this item (p = .0720) between the technology education students and the general education students.

Item 17e asked students if it was absolutely true, probably true, probably false, or absolutely false as to whether or not antibiotics kill viruses as well as bacteria. As it is relatively common knowledge that antibiotics cannot kill viruses, the correct answer is false. Even with combining both the probably false and absolutely false options together, only 25.8% of technology education students correctly answered the question whereas over sixty (60.8%) of the PLTW® students answered the question correctly. It is also interesting to note that although not significantly different ($p = .8586$), a higher percentage (27.2%) of general education students answered correctly. There was also a significant difference ($p = .0212$) between the general education students and the PLTW® students in regard to this item.

Item 22c asked how important it was for schools to prepare students in regard to knowing something about how products are designed. The combined total of both the very important and fairly important selections yielded 92.4% of technology education students believing that schools should prepare students about how products are designed, where as only 69.6% PLTW®, and 76.5% of general education students respectively believed that schools should prepare students about how products are designed. Although not significantly different than that of general education students ($p = .2478$), it is interesting that PLTW® students have the lowest belief that schools should prepare students to know something about how products are designed considering that one of the primary concepts of PLTW® is to teach the essence of engineering design (Blais & Adelson, 1998).

Item 22e asked students how important it was for schools to prepare students to understand the advances and innovations in technology. Over ninety percent (90.8%) of technology education students believed it was either very important or fairly important for schools to prepare students to understand the advances and innovations in technology, while 73.9% of PLTW® and 86.6% of general education students believed that it was either very important or fairly important for schools to prepare students to understand the advances and innovations in technology. It should also be noted that there was a significant difference (p = .0366) between the PLTW® student group and the general education student group.

Item 28c asked the students how informed they were about new construction methods for homes and buildings. Of the technology education students, 81.5% noted that they were either very informed or somewhat informed with new construction methods of homes and buildings. Of the PLTW® students 56.5% and only 50% of general education students believed that they were informed of new construction methods for homes and buildings. This item also showed a significant difference between the technology education and general education groups (p = .0043) which is understandable since the general education students' cumulative percentage was less than the PLTW® group.

Research Question 4 determined if students who completed a Project Lead the Way® pre-engineering course would have the same perception of technology as students who were enrolled in only general education courses. Six instrument items were found to be significant between the student groups. The data analysis of items 13b (p = .0434), 14 (p = .0594), 17c (p = .0267), 17e (p = .0647), 22e (p = .0890), and 25a (p = .0644) demonstrated that there was a significant difference in these six survey items. As noted earlier, items 13b, 17e, and 22e also showed significant differences between the PLTW® and technology education student groups.

Item 14 asked students to which of the following (our society, our environment, the individual, don't know) do you feel technology is of the most importance and has the greatest effect? Technology education, PLTW®, and general education students were all similar in their highest percentage responses (70.7%, 69.6%, 71.4%) respectively by selecting "our society" as their option. PLTW® and general education students however did have a statistical difference ($p = .0767$) toward the other options available for selection. PLTW® students rated "the individual" (21.7%) and "our environment" (8.7%) as their second and third options, whereas the general education students rated "the individual" at 5.7% and "our environment" at 15.7%.

Item 17c asked students if it was absolutely true, probably true, probably false, or absolutely false as to whether a car operates through a series of explosions. Combining the absolutely true and probably true responses yielded percentage total of 70.7%, 73.9%, and 68.1% for the technology education, PLTW®, and general education student groups respectively. Likewise, tabulating the absolutely false and the probably false responses yielded percentage totals of 29.3%, 26%, and 31.8% respectively. From first view of these data, it appears that all three groups are very similar in their combined response totals, but there was a significant difference ($p = .0388$) between the PLTW® and general education student groups as well as a difference ($p = .0138$) between the technology education and PLTW® student groups.

Item 25a asked students how important it was for them personally to know whether it is better to repair products or better to throw them away. There was a significant difference ($p = .0416$) between the PLTW® student group and the general education student group. Combining the very important and somewhat important responses together illustrated very close results between technology education (96.3%), PLTW® (87%), and general education (92.6%). However, upon combining the not very important and not very important at all responses determined that 13% of the PLTW® students do not know whether or not it is better to repair products or better to throw them away as compared to only 3.7% of technology education and 4.4% general education students calculated totals. This item's analysis showed further disconnect between the PLTW® students and their understanding of product design.

Research Question 5 sought to determine if students who completed a *Fundamentals of Technology* course would have the same perception of technology as students who were enrolled in only general education courses. Eight of the thirteen survey instrument items were found to be significantly different between the two student groups. The data analysis of items 9 ($p = .0018$), 12 ($p = .0659$), 16a ($p = .0307$), 16d ($p = .0124$), 17c ($p = .0267$), 22c ($p = .0150$), 24 ($p = .0287$), and 28c ($p = .0079$) demonstrated that there was a significant difference in these eight survey items. As noted earlier, items 9, 16a, 22c, and 28c were also found to be significantly different between the PLTW® and technology education whereas item 17c was found to be significantly different between the PLTW® and general education group.

Item 12 asked students to describe their attitude towards the various forms of technology they use in everyday life. The two choices included "you don't care how it works as long as it works" and "you would like to know something about how it works". Technology education student response was 86.2% while 69.6% of PLTW® students and 77.1% of general education students responded they would like to know something about how technology works. The primary difference between groups was in the other response where 13.8% of technology education students, 26.1% of PLTW® students, and 12.9% of general education students responded that they did not care how technology worked as long as it worked for them. It would appear that the major difference between groups would be between the PLTW® students and the general education students. However, because there was a "don't know" selection for this item in which 10% of the general education students selected, caused the significant difference (p = .0464) between the technology education students and the general education student groups.

Item 16d asked students to answer yes or no as to whether or not they could explain how a home heating system worked to a friend. Over half (58.6%) of technology education students believed they could explain how a home heating system worked to a friend, where as 60.9% of PLTW® students and 67.1% of general education students did not believe they could explain to a friend how a home heating system worked. The statistical difference between the technology education group's response and the general education group's response was p = .0035.

Item 24 asked students how important it was for students to know how various technologies work. Of the student responses, 94.5% technology education, 95.7% of PLTW® students, and 98.2% of general education students responded that it is either very important or somewhat important for them to know how various technologies work. The significant difference (p = .0210) lies in the cumulative responses "not very important" and "not very important at all" where 5.6% of technology education students and only 1.5% of general education students do not believe that it is important for students to know how various technologies work.

SUMMARY

The findings presented in this chapter indicate that respondents were 80% male for those students in the technology education and PLTW® groups, while there was a relatively even distribution of males (54.3%) and females (45.7%) in the general education group. Caucasian/white ethnicity was the majority of all three student groups followed by African-Americans.

This study investigated five research questions. Research Question 1 compared student response data from this study with adult respondent data from the 2001 and 2004 *ITEA/Gallup Polls*. The data were descriptively analyzed. Research Question 2 examined each of the student groups' respondent data to determine if a statistical difference existed between two or more of the student groups. Research Questions 3, 4, and 5 sought to determine the actual item differences between each student group pair. Pearson's chi-square was used to test the significance between data sets and theory. There were 66 original survey items, one of which was not used due to a typographical error, leaving 65 usable survey items. Of those 65 usable items, 13 items were found to be significantly different between two or more student groups.

Research Questions 3, 4, and 5 further assessed the different group pairing's responses in order to determine if a statistically significant difference was found. Each student group pairing was aligned with a research question. Alpha was set at .1 for each research question and the p-value needed to be less than alpha for there to be a statistically significant difference between each pair of group item responses. Research Question 3 determined if students who completed the *Fundamentals of Technology* course would have the same perception of technology as students who completed a Project Lead the Way® pre-engineering course. Seven of the thirteen survey instrument items were found to have a significant difference between the two groups. Research Question 4 sought to determine if students who completed a Project Lead the Way® pre-engineering course would have the same perception of technology as students who were enrolled in only general education courses. Six of the thirteen survey instrument items were found to differ significantly between the student groups. Research Question 5 determined if students who completed a *Fundamentals of Technology* course would have the same perception of technology as students who were enrolled in only general education courses. Eight of the thirteen survey instrument items were found to be significantly different between the two student groups.

Chapter V presents a summary of the research study and develops conclusions based on the data. Additionally, recommendations based on the data analysis are determined.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMENDATIONS

This study compared high school student's perceptions of technology and technological literacy to those perceptions of the general public. The student population in question consisted of three subgroups: students enrolled in a standards-based technology education course, students enrolled in a Project Lead the Way® (PLTW®) *Principles of Engineering* pre-engineering course, and students enrolled in a general education course (language arts, mathematics, or science). In addition, this study compared students' perceptions of technology among the students enrolled in a high school technology education course, a Project Lead the Way® pre-engineering course, or a general education course.

This study was the result of several school districts in the state of North Carolina starting Project Lead the Way® pre-engineering programs as replacement courses for technology education programs, although it has been well documented (Rogers, 2005; Rogers, 2006; SREB, 2001; Lewis, 2004) in editorials and research of how PLTW® and technology education programs are not interchangeable. The purpose of this study was to assess high school students' perceptions of technology amongst each other and the general adult populations' perception of technology. A comprehensive review of related literature and research was conducted with emphasis placed on three primary topics concerning the study: technological literacy, pre-engineering education, and the *ITEA/Gallup Poll's* construction and history. Five research questions were formulated from the study's problem statement and review of related literature. These included:

1. Do high school students' perceptions of technology differ from adult's perceptions of technology?
2. Are the perceptions of technology the same for student's that complete a Project Lead the Way® pre-engineering course, students who complete the *Fundamentals of Technology* course, and students who are only enrolled in general education courses?
3. Do students who complete the *Fundamentals of Technology* course have the same perception of technology as students who complete a Project Lead the Way® pre-engineering course?
4. Do students who complete a Project Lead the Way® pre-engineering course have the same perception of technology as students who are enrolled in only general education courses?
5. Do students who complete the *Fundamentals of Technology* course have the same perception of technology as students who are enrolled in only general education courses?

A convenience sample of programs were selected from the entire population of *Fundamentals of Technology* programs and Project Lead the Way® pre-engineering programs identified by the North Carolina Department of Public Instruction. Further, ten general education teachers were recruited to participate in the study. A total of 29 teachers including, 10 *Fundamentals of Technology*, 9 PLTW®, and 10 general education, were mailed a cover letter explaining the study, parent consent form, student participation form, a reference copy of the survey including specific demographic information, and a combined version of the 2001 and 2004 *ITEA/Gallup Polls*. A total of 151 students were surveyed, 58 of which were enrolled in technology education classes, 23 in PLTW® classes, and 70 enrolled in general education classes.

To investigate the research questions, Pearson's chi-square test was used and illustrated that 13 of the 65 survey instrument items were shown to have a significant difference between two or more student groups. Data analyzed from Research Question 3 illustrated that seven of the 13 items (9, 13b, 16a, 17e, 22c, 22e, 28c) illustrated a significant difference between the technology education and PLTW® student groups. Research Question 4 displayed a significant difference in six of the 13 items (13b, 14, 17c, 17e, 22e, 25a) between the PLTW® and general education student groups. Lastly, Research Question 5 noted that eight of 13 items (9, 12, 16a, 16d, 17c, 22c, 24, 28c) were shown to be significantly different between the technology education and general education student groups.

CONCLUSIONS

The following conclusions were determined from the findings of this study and relate to the problem statement and subsequent research questions. Caution should be taken concerning the generalizability of these conclusions beyond the technology education, PLTW®, and general education students in North Carolina who responded to this study.

1. After descriptively analyzing the differences and similarities between the students surveyed in this study and the adults surveyed in the 2001 and 2004 editions of the *ITEA/Gallup Poll*, very few differences were revealed between the different groups. However, responses from items 18, 19, 22a, and 32 showed descriptive

differences between students and adults. These items are reported below with an explanation of why the differences may exist between the two groups.

Item 18 asked respondents to determine whether the United States should bring in technologically literate people from other countries or take steps through our schools to increase the number of technologically literate people in our country when a shortage of qualified people occurs in a particular area of technology. Ninety-three percent of adults believed that the United States should take steps in our schools to increase the number of technologically literate people as compared to only 70.9% of students. Perhaps the discrepancy between the student and adult groups deal with the fact that students are currently in school and believe they may have to take courses which help them to become technologically literate and do not foresee the possible negative implications of bringing in technologically literate people from other countries to solve our country's technological problems.

Item 19 defined technology as "modifying our natural world to meet human needs" and asked respondents if they believed the study of technology based on this definition should be included in school's curriculum. Ninety-seven percent of adults and 86.8% of students believed that the study of technology should be included in school curriculum. Although not as varied as item 18's responses between adults and students, further investigation into this item should commence due to the response differences. Perhaps the reason the student's yes response to this item was lower than that of the adults was primarily due to the students currently being in school and believing that they may be susceptible to additional coursework encompassing technology as a subject area if they responded favorably to the item.

Item 22a asked respondents how important it was for schools to prepare students to understand the relationship between science, technology, and mathematics. Ninety-eight percent of adults and 93.1% of students responded that it is either very important or fairly important that schools prepare students to understand the relationship between the three disciplines. This item illustrates that students, even at a relatively young age, understand that these disciplines are not mutually exclusive of one another and the relationship between these disciplines grow stronger as the disciplines continue to evolve.

Lastly, item 32 informed respondents that the federal government requires students to be tested in science, mathematics, and reading and asked respondents if these tests should include questions to help determine how much students understand and know about technology. Eighty-eight percent of adults and 57.2% of students believed that questions designed to determine understanding and knowledge of technology should be included in these national assessments. Although this item is similar to items 18 and 19 which may lead students to believe that if this item was represented in a positive light, students may be required to be evaluated on the concepts of technology. Nearly sixty percent of the student respondents found it important for the nation to assess student's understanding and knowledge of technology. Likewise, adults greatly see the need to assess technology skills. This is consistent with numerous professional organizations involved in science, mathematics, and technology education.

2. The technology education and Project Lead the Way® student groups had seven survey items that showed a significant difference between the two groups. Of those seven items, item 9 gave students two definitions and asked them to select which definition they most closely believed was the definition of technology. The technology education students by and large (98.2%) believed that technology, by definition was the changing of the natural world to satisfy our needs as compared to both of the other student groups that believed technology was just computers and the internet. This perspective of technology that both the PLTW® and general education students believed is very narrow in definition. This narrow definition correlates with both the original *ITEA/Gallup Polls* (2001/2004) adult respondents' definition of technology although organizations such as the International Technology Education Association (ITEA), National Science Foundation (NSF), National Research Council (NRC), and National Academy of Engineering (NAE) agree with the much broader definition of technology as changing the natural world to satisfy human needs.
3. The narrow scope of technology (computers and the internet) in which PLTW® student respondents selected as being the definition of technology may perhaps be the foundation for responses on several other items. For example, item 22e asked how important it was for schools to prepare students to have an understanding of the advances and innovations in technology. Perhaps the reason item 22e showed a significant difference between the technology education and PLTW® student groups dealt with the narrow definition of technology. If the majority of students believed that the definition of technology was simply "computers and the

internet", it is not surprising that item 22e, which was not found to be as important as the technology education students due to their perceived definition of technology. Therefore, due to the majority of PLTW® students perceived definition of technology, item 22e would not seem to be very important to those students as they believe they can learn about the advances and innovations of computers and the internet on their own without formal schooling on the subject matter.

4. Item 12 gave students two statements (Don't care how it works as long as it works, Would like to know something about how it works) and asked students which of the two statements best described their attitude toward the various forms of technology they use in everyday life. This item seems to indicate support for broad-based technological literacy as a majority of respondents from technology education (86.2%), PLTW® (69.6%), and general education (77.1%) groups stated that they would like to know something about how various forms of technology worked.
5. Item 13b, which asked respondents whether the results of the use of technology could be both good and bad, alludes to the socio-cultural aspect of technology. It is perhaps understandable as to why there was a difference between the technology education and PLTW® groups due to the fact that STL standards 4-7 directly relate technology and society. As each of the technology education respondents were enrolled in a standards-based technology course, and the fact that 4 of the 20 STL standards address technology and its socio-cultural aspects directly, there was a significant difference between the PLTW® and the

technology education student groups. Although PLTW® does incorporate STL into its curriculum, the technology and society standards may either not be addressed or not properly emphasized in its curriculum. Another conlusion is the significant difference between the PLTW® and general education student groups since students enrolled in general education courses are not exposed to STL, yet differ significantly between the PLTW® student group in believing that the results of the use of technology can be both good and bad.

6. Another difference between technology education students and PLTW® students was illustrated on item 16a which asked students whether or not they could explain to a friend how a flashlight worked. A large majority of PLTW® (91.3%) and general education (79.7%) students believed that they could indeed explain how a flashlight worked to their peers where only 65.5% of technology education students believed they could explain the function of flashlight operation to a friend. Perhaps one reason technology education students may not believe they can adequately explain the function of a flashlight to a friend is due to the concepts they may have learned in their technology course such as: D/C theory, electricity, electronics, and luminescence that are all incorporated into the function of a flashlight. These concepts can often be considered abstract and could also not be incorporated into the technology education curriculum in detail. Technology education students may have realized that in order to truly be able to explain how a flashlight worked to their friends, they would need to know these concepts learned in their technology class thoroughly, and since those concepts were just perhaps introduced to the technology education students, those students

may not believe they can adequately explain how a flashlight worked. Likewise, because general education and PLTW® students may or may not have studied those specific concepts pertaining to a flashlight and simply believe that flashlights operate by connecting dry-cell batteries, a switch, and a light bulb together in order to complete the circuit.

7. Item 17e asked students whether or not antibiotics killed both bacteria and viruses. Antibiotics kill only bacteria, yet only 25.8% of technology education students and 27.2% of general education students either believed that the statement was either probably false or absolutely false as opposed to 60.8% of PLTW® student groups. The fact that just over one in four technology education students believe that antibiotics only kill bacteria could perhaps mean that technology education curricula should intensify its instruction on medical technology in standards-based technology education classes. Additionally, as similar percentages suggest, based on the sample obtained from the general education students, science courses should place greater emphasis on medical technology. As noted in Table 4 in Chapter IV, the sample of PLTW® students surveyed in this study, as a majority, have taken more advanced science courses than the technology and general education students which may affect the PLTW® group's response to this survey item.

8. Another conclusion derived from the technology education and PLTW® student groups was in item 22c, which asked how important it was for schools to prepare students to know something about how products are designed. An overwhelming majority (92.4%) of technology education students believed that it was either very

important or fairly important for schools to prepare students to know something about how products are designed as compared to 69.6% PLTW® and 76.5% of general education respondents. It is not surprising that a strong majority of technology education students believed that schools should prepare students to know something about how products are designed as that is an enduring concept taught in technology education classes, but it was interesting, albeit not statistically significant, that students in the general education classes, as a majority, found the item to be either very important or fairly important, collectively, than that of the PLTW® student group. This is rather interesting considering that one of the PLTW's® core competencies is teaching the engineering design process through a variety of means. One would think that students who are enrolled in PLTW® courses would as a majority, have a greater belief that schools should teach students about how things are designed than general education students. Although PLTW® teaches engineering design as one of its core competencies, PLTW® may not include aspects of marketing, product life cycle, and other aspects of product design.

RECOMENDATIONS

The following recommendations for further research are based on the findings and conclusions of this study. This section highlights recommendations for studies concerning ways of developing technological literacy with pre-engineering education.

1. The respondent's conceptions of technology in both the original *ITEA/Gallup Poll*s (2001/2004), along with the sample of PLTW® and general education students from this study differ from numerous professional organization's

definition of technology such as ITEA (ITEA 2000/2002) and the National Academy of Engineering (Pearson & Young, 2002). But once given this definition, the general public finds it to be a beneficial course of study in public education. This researcher suggests that perhaps technology education should add the clarifying term engineering in their names, as the word engineering, has a more universal and accepted connotation with the public than that of technology (i.e. Wicklein, 2006; Lewis, 2005; ITEA, 2009a; ITEA, 2009b, Starkweather, 2008).

2. Although the sample for this study was not large enough to draw conclusions on the entire population, school systems can use the data presented in this study to aid in their decision making regarding whether or not to replace a technology education program with a PLTW® pre-engineering program in their schools. Although this was one of the original premises for the study, the researcher suggests that school system administrators should not necessarily decide whether or not they should include technology education and/or pre-engineering education into their schools based solely on the findings presented in this study. Rather, administrators should focus on the needs of the students in their community as to whether the community needs an engineering and/or engineering technology workforce or does the community need an informed, technologically literate citizenry, or a combination of both.
3. As there was a lack of respondents in each of the three groups, these findings can only apply to the sample taken and not to the entire population. For this reason, replication of this study is highly recommended. Replication in other states can

also be helpful for comparison purposes. A larger sample is also suggested to aid with proper data acquisition. Technological literacy researchers should also strive to incorporate the *ITEA/Gallup Poll* in other countries in order to develop a line of inquiry across the world (Volk, 2005).

4. Replicated future studies should seek assistance from state and/or district supervisors to have their school districts and teachers to participate in the study. Although proper permission was granted from school districts to have PLTW® programs participate in the study, some PLTW® teachers were reluctant to actually carryout the research project even though when first contacted by the researcher, they agreed to participate in the study. Perhaps having a formal letter from the state PLTW® supervisor granting permission to participate in the study would possibly help alleviate some of the PLTW® teacher's concerns.
5. This study was designed to assess perceptions of technology and as the literature review suggests at the time of this study, there was no one instrument that assessed all three dimensions of technological literacy (Gamire & Pearson, 2006; Petrina & Guo, 2004). However, the researcher believes that once a technological literacy assessment is developed which assesses all three dimensions, a similar study should be developed utilizing the instrument with the same three student groups. As noted earlier in this study the Education Testing Service (ETS) is working with the National Assessment of Educational Progress (NAEP) to develop items that assess technological literacy. Curriculum models such as PLTW® and EbD™ have developed items specific to their curricula but still assess multiple dimensions of technology and technological literacy. Perhaps

these curriculum specific assessment items could be revised and/or formulated to fit in the context of large-scale technological literacy assessments such as those ETS is developing with NAEP. Similarly, it is the recommendation of this researcher that curriculum programs that focus on technological literacy should partner with NAEP and other professional organizations specializing in the assessment of technological literacy to stress the importance of assessing for technological literacy in United States' students.

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Appendix A: 2001 and 2004 ITEA/Gallup Poll Survey Instrument Items

Questions are numbered in reference to the survey instrument used in the study. The number and year in parentheses next to each survey item indicates the original ITEA/Gallup Poll's item number and installment year.

Note: Items 1-6 are located in Appendix B.

7. (1, 2001) Just your opinion, how important it is for all people at all levels to develop some ability to understand and use technology? (very important, somewhat important, not very important, not important at all, didn't know/refused)
8. (2, 2001) When you hear the word "technology" what first comes to mind?
9. (3, 2001) I want to give you two definitions and as you to tell me which more closely fits when you hear the word, "technology". Do you think of "computers and the internet", or do you think of "changing the natural world to satisfy our needs?"
10. (4, 2001) When you hear the word "design" in relation to technology, which one are you more likely to think of – "a creative process for solving problems" or blueprints and drawings from which you construct something?"
11. (5, 2001) To what extent do you consider yourself to be able to understand and use technology? Would you say a great extent, some extent, to a limited extent, or not at all?
12. (6, 2001) Which of the following statements best describes your attitude toward the various forms of technology you use in your everyday lives. (You don't care how it works as long as it works, You would like to know something about how it works, didn't know/refused)
13. (7, 2001) Do you strongly agree, mostly agree, mostly disagree, or strongly disagree with each of the following statements.
    a. Technology is a major factor in the innovations developed within a country.
    b. The results of the use of technology can be good and bad.
    c. Engineering and technology are basically one and the same thing.
    d. Science and technology are basically one and the same thing.
    e. Technology is a small factor in your everyday life.
14. (8, 2001) To which of the following do you feel technology is of the most importance and has the greatest effect? (our society, our environment, the individual, didn't know/refused)
15. (9, 2001) How much input do you think you should have in decisions in each of the following areas – a great deal, some, not very much, or none at all? How about?
    a. Designation of neighborhood community centers.
    b. Where to locate roads in your community.
    c. Development of fuel-efficient cars.
    d. Development of genetically modified foods.
16. (10, 2001) Let me ask you if you could explain each of the following to a friend; just answer "yes" or "no." Could you explain:
    a. How a flashlight works.
    b. How to use a credit card to get money out of an ATM.
    c. How a telephone call gets from point A to point B.
    d. How a home heating system works.
    e. How energy is transferred into electrical power.

17. (11, 2001) Tell me if each of the following statements are true or false.
    a. Using a portable phone while in the bathtub creates the possibility of being electrocuted.
    b. FM radios operate free of static.
    c. A car operates through a series of explosions.
    d. A microwave heats food from the outside to the inside.
    e. (7a, 2004) **SEE QUESTION 26a**
18. (12, 2001) When a national shortage of qualified people occurs in a particular area of technology, which of the following solutions would you feel is the most appropriate course of action for the U.S. to take?
    - Bring in technologically literate people from other countries.
    - Take steps through our schools to increase the number of technologically literate people in this country.
19. (13, 2001) Using the broad definition of technology as "modifying our natural world to meet human needs," do you believe the study of technology should be included in the school curriculum, or not?
20. (14, 2001) *Asked of those saying it should be included in the curriculum* Should the study of technology be made part of other subjects like science, math, and social studies, or should it be taught as a separate subject?
21. (15, 2001) *Asked of those saying "separate subject"* Should the subject be required or optional?
22. (16, 2001) Tell me how important it is for schools to prepare students in the following areas. Would you say it is very important, fairly important, not very important, or not important at all?
    a. The relationship between technology, mathematics and science.
    b. The role of people in the development and use of technology.
    c. Knowing something about how products are designed.
    d. The ability to select and use products.
    e. An understanding of the advances and innovations in technology.
23. (17, 2001) Should students be evaluated for technological literacy as part of the high school graduation requirements? (Yes, No, didn't know/refused)
24. (3, 2004) How important is it to you to know how various technologies work? Is it very important, somewhat important, not very important, not important at all?
25. (4, 2004) How important is it to you personally to know each of the following. Is it very important, somewhat important, not important, or not very important at all?
    a. Knowing whether it's better to repair products or better to throw them away.
    b. Diagnosing why something doesn't work so it can be fixed.
    c. How to program a VCR or use other "thinking" products.
    d. Being able to develop solutions to a practical technological problem.
    e. How to fix a light switch or other household product that stops working.
    f. Knowing how products such as a paper staples work.
26. (7, 2004) Please tell me if you think the following statements are absolutely true, probably true, probably false, or absolutely false.
    a. Antibiotics kill viruses as well as bacteria. **(Survey Item 17e)**
    b. Using a cordless phone while in the bathtub creates the possibility of being electrocuted.
    c. The Internet and the World Wide Web are the same thing.
    d. Fuel cells are now being used with gasoline or diesel engines to power cars.

27. (8, 2004) How much of an interest do you, yourself, have in the following topics? Are you interested, somewhat interested, not interested, or not interested at all?
    a. Modification of plants and animals to supply food.
    b. Robotics and other technologies in manufacturing.
    c. New construction methods for homes and buildings.
    d. Space exploration.
28. (9, 2004) Please tell me how informed you are about each. Would you say you are very informed, somewhat informed, not very informed, or not informed at all?
    a. Modification of plants and animals to supply food.
    b. Robotics and other technologies in manufacturing.
    c. New construction methods for homes and buildings.
    d. Space exploration.
29. (10, 2004) How much influence do you think people like yourself have on decisions about such things as fuel efficiency of cars, the construction of roads in your community, and genetically modified foods? Would you say a great deal, some, very little, or no influence?
30. (11, 2004) Thinking about such things as fuel efficiency of cars, the construction of roads in your community, and genetically modified foods, how much confidence do you have in experts in these fields to make the right decisions for your community? Would you say a great deal of confidence, some confidence, very little confidence, no confidence?
31. (13, 2004) Tell me how important it is that high school students understand and are able to do each.
    a. Have the knowledge and skills to apply technology.
    b. Understand the overall effect of technology on our society.
    c. Understand the relationship between technology and the environment.
    d. Understand the relationships between technology and the economy.
    e. Evaluate the pros and cons of specific technology uses.
32. (15, 2004) The federal government requires that students be tested in science, mathematics, and reading. In your opinion, should these tests include or not include questions to help determine how much these students understand and know about technology?

Appendix B: Demographic Questionnaire Items

Demographic Questions

1. In which class are you taking this survey?
    a. Technology education.
    b. Project Lead the Way®.
    c. English or other class.
2. What is your gender?
    a. Male.
    b. Female.
3. What is your ethnicity?
    a. African American.
    b. Asian.
    c. Hispanic.
    d. White.
    e. Other.
4. Not including the technology and/or engineering course you are currently enrolled in, how many technology and/or engineering courses have you taken?
    a. 0.
    b. 1.
    c. 2.
    d. 3 or more.
5. Please check all of the following math courses you have taken or are currently taking.
    a. Algebra 1.
    b. Algebra 2.
    c. Geometry.
    d. Trigonometry.
    e. Pre-Calculus.
    f. Calculus.
6. Please check all of the following science courses you have taken or are currently taking.
    a. Physical Science.
    b. Biology.
    c. Chemistry.
    d. Physics.

Appendix C: Welcome Letter to Teachers

April 24, 2009

Dear Teachers,

We are conducting a study involving student perceptions of technology in standards-based technology education courses and Project Lead the Way® pre-engineering courses. To conduct this study, we are asking for you and your students who are enrolled in technology education courses, Project Lead the Way® pre-engineering courses, or general education courses to participate in this study.

Included in this packet is a hardcopy of the survey instrument for your reference, instructions for you to inform your students how to access and complete the survey instrument online, a parent's letter discussing the study with the attached "Permission for Child's Participation" form for which parents must sign for students to participate in the study, and a "Willingness to Participate" letter for students to read and sign. If you have any questions pertaining to the attached forms or to the research study, please feel free to contact Hal Harrison or Dr. Philip Reed at the numbers below.

There are twenty copies of the parent's letter with the attached "Permission for Child's Participation" form and "Willingness to Participate" form included in this packet. If you have more than twenty students, please make additional copies as needed. Please distribute the parent's letter to your students and have them take the letter and attached permission form home and ask them to have their parents read the letter, sign the permission form, and return it back to you. Once the parental permission forms are returned, please have students read and sign the "Willingness to Participate" form. After these forms have been signed, please set aside 20-25 minutes in your class so students can complete the online survey instrument. In order for students to complete the survey, they will each need a computer with internet access.

After the students complete the survey, please email Hal Harrison (hlh@clemson.edu) informing Hal that your class has completed the survey. Also, place each signed "Permission for Child's Participation" and "Willingness to Participate" form in the self-addressed mailing envelope and mail them back to the address listed on the envelope. Please be sure to put your name and school name on the return address of the envelope. Upon receiving the permission forms, we will gladly send you reimbursement for any mailing expenses that you may incur.

We thank you in advance for helping with our study.

Sincerely,

Hal Harrison
Ph. D. Candidate
Old Dominion University
864-656-6967
hlh@clemson.edu

Philip Reed, Ph. D.
Associate Professor
Old Dominion University
757-683-5226
preed@odu.edu

Appendix D: Parent Permission Request Letter and Form

April 24, 2009

Dear Parents,

We are conducting a study involving student perceptions of technology in standards-based technology education courses and Project Lead the Way® pre-engineering courses. To conduct this study we need the participation of students enrolled in technology and non-technology courses in the state of North Carolina. The attached "Permission for a Child's Participation" form describes the study and asks your permission for your child to participate.

Please carefully read the attached "Permission for Child's Participation" form. It provides important information for you and your child. If you have any questions pertaining to the attached form or to the research study, please feel free to contact Hal Harrison or Dr. Philip Reed at the numbers below.

After reviewing the attached information, please return a signed copy of the "Permission for the Child's Participation" form to your child's teacher if you are willing to allow your child to participate in the study. Keep the additional copy of the form for your records. Even when you give consent, your child will be able to participate only if he/she is willing to do so.

We thank you in advance for taking the time to consider your child's participation in this study.

Sincerely,

Hal Harrison
Ph. D. Candidate
Old Dominion University
864-656-6967
hlh@clemson.edu

Philip Reed, Ph. D.
Associate Professor
Old Dominion University
757-683-5226
preed@odu.edu

PERMISSION FOR CHILD'S PARTICIPATION

The purposes of this form are to provide information that may affect decisions regarding your participation and to record consent of those who are willing to participate in this study.

TITLE OF RESEARCH: Comparing Students' Perceptions of Technology.

RESEARCHERS: Philip Reed, Ph. D., Responsible Project Investigator, Old Dominion University
Hal Harrison, co-investigator, Old Dominion University Ph. D. Candidate

DESCRIPTION OF RESEARCH STUDY: The purpose of this study is to compare students' perceptions of technology after they have enrolled and taken courses in a standards-based technology education course or a Project Lead the Way® pre-engineering course. In addition to comparing data between the two courses of study, a sample of students who are enrolled in neither course will serve as a group of students. This survey is being administered online to schools having either a standards-based technology education course or Project Lead the Way® pre-engineering course in the state of North Carolina.

If you decide to allow your child to participate in this study, your child will be asked to complete an online survey one time near the conclusion of the course in which he/she is currently enrolled. Approximately 550 students will be recruited to participate in this study. Your child's participation will take approximately 25 minutes to complete the survey. Your child will be able to complete the survey via the Internet from school. Your child's choice to participate will in no way affect your child's grade in any of the courses they are taking.

RISKS: There are no known risks associated with this project.

BENEFITS: There are no direct benefits to students who participate in this study. It is our hope however, that as a result of this project, we expect to understand if there is a differing student perception of technology in students who enroll and take high school standards-based technology education courses as compared to students who enroll and take Project Lead the Way® pre-engineering courses. This research is beneficial to the future of technology and the pre-engineering education profession in the United States and will be published in the form of a doctoral dissertation for future review.

COSTS AND PAYMENTS: There are no costs for your child to participate in this study, other than the time required to complete the survey. There is no compensation for participation in this study.

NEW INFORMATION: You will be contacted if new information is discovered that would reasonably change your decision about your participation in this study.

CONFIDENTIALITY: Participants will access the online survey in such a way that your child's name will not be attached to his or her responses. Only researchers involved in the study or in a professional review of the study will have access to the data. Your child's teacher will not have access to these data. All data and participant information will be kept by the researchers in a locked and secure location. All reports of these data will provide data in summary form without reference to individual responses.

<u>WITHDRAWAL PRIVILEGE</u>: Your child's participation in this study is completely voluntary. It is alright to refuse your child's participation. Even if you agree now, you may withdraw your child from the study at any time. In addition, your child will be given a chance to withdraw at any time if he/she so chooses.

<u>COMPENSATION FOR ILLNESS AND INJURY</u>: Agreeing to your child's participation does not waive any of your legal rights. However, in the event of harm arising from this study, neither Old Dominion University nor researchers are able to give you any money, insurance coverage, free medical care, or any other compensation. In the event that you suffer harm as a result of participation in this research project, you may contact Dr. Philip Reed at 757-683-5226 or Dr. George Maihafer, Chair of the Institutional Review Board at 757-683-4520.

If at anytime you feel pressured to participate, or if you have any questions about your rights or the form, please call Dr. George Maihafer, Chair of the Institutional Review Board Chair (757-683-4520) or the Old Dominion University Office of Research (757-683-3460).

Please check yes or no below, sign, and have your son/daughter return this form to their teacher. Please keep one copy of this form for your records.

_____ **Yes, my son/daughter may participate in this survey.**
_____ **No, I would not like my son/daughter to participate in this survey.**

Your name (please print): ____________________

Your signature: ____________________

Date: ____________________

<u>INVESTIGATOR'S STATEMENT</u>: I certify that this form includes all information concerning the study relevant to the protection of the rights of the participants, including the nature and purpose of this research, benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human research participants and have done nothing to pressure, coerce, or falsely entice the parent to allowing this child to participate. I am available to answer the parent's questions and have encouraged him/her to ask additional questions at any time during the course of the study.

Experimenter's signature: ____________________

Date: ____________________

Appendix E: Student Willingness to Participate Form

WILLINGNESS TO PARTICIPATE

Technology Perceptions Survey

My name is Hal Harrison, I am a student at Old Dominion University.

I am asking you to take part in a research study because I am trying to learn more about perceptions of technology in students who take technology education classes and pre-engineering classes.

If you agree, you will be asked to complete a survey near the end of this school year. You will be asked about your experience with math and science instruction as well as some general thoughts about technology and its definition. Answering these questions will take about 5 minutes each time you complete a survey. You will complete the survey on a computer in your class. Your answers will not be linked to your name.

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Even if you start, you can stop later if you want. You may ask questions about the study.

If you decide to be in the study I will not tell anyone else what you say or do in the study. Even if your parents or teachers ask, I will not tell them about what you say or do in the study.

Please check yes or no below, sign, and return this form to your teacher. Please keep one copy of this form for your records.

_____ **Yes, I would like to participate in this study.**
_____ **No, I would not like to participate in this study.**

Signature of subject____

Subject's printed name ____

Signature of investigator____

Date___________________________

Henry L. (Hal) Harrison III

Education

2009	Doctor of Philosophy	Occupational and Technical Studies	Old Dominion University
2003	Master of Education	Technology Education Minor in Curriculum & Instruction	North Carolina State University
2002	Bachelor of Science	Technology & Human Resource Development	Clemson University

Professional Experience

9/05 – Present	Clemson University, Clinical Faculty
1/04 – 9/05	Clemson University, Lecturer
8/02 – 12/03	North Carolina State University, Research/Teaching Assistant

Professional Society Membership

International Technology Education Association (ITEA)
Epsilon Pi Tau Honor Society (EPT)
South Carolina Technology Education Association (SCTEA)
National Technology Student Association (TSA)
ITEA Technology Education Collegiate Association (ITEA-TECA)
Council on Technology Teacher Education (ITEA-CTTE)
2003 to 2006 - CTTE College Student Committee
2006 to Present - CTTE Leadership Development Committee
2004 to Present - SCTEA Board of Directors
2005 to 2007 - SCTEA Vice President
South Carolina Technology Student Association (SCTSA)
2005 to Present - SCTSA, INC. Board of Directors
Gamma Beta Phi National Academic Honor Society
Southeastern Technology Education Conference (STEC)
2005 to Present - STEC Secretary/Treasurer
2005 to Present - ITEA Committee of 100
July 2006 to 8 August 2008 - SCTSA State Advisor
2006 CTTE 21st Young Leaders Consortium
2007 to Present - ITEA Elections Committee
2007 Golden Key International Honor Society Invitee
2007 to 2008 - ITEA CTTE Research Task Force
2008 to Present ITEA Big Ideas / Promotions Task Force

National Presentations

Reed, P. A, et. al. (2008, February). *Yes, there is research support for technology education.* Presentation at the ITEA National Conference, Salt Lake City, UT.

Harrison, H. L., & Hummell, L. J. (2008, February). *Video production technology: Using claymation to teach concepts.* Presentation at the ITEA National Conference, Salt Lake City, UT.

Harrison, H. L., & Loveland, T. (2008, February). *Television commercial projects in communication technology.* Presentation at the ITEA National Conference, Salt Lake City, UT.

Harrison, H. L., & Loveland, T. (2006, March). *Video production technology: A new technological curricula.* Presentation at the ITEA National Conference, Baltimore, MD.

Harrison, H. L., & Ernst, J.V. (2006, March). *Integrating communications technology into the elementary classroom.* Presentation at the ITEA National Conference, Baltimore, MD.

Referred Publications

Harrison, H. L., & Loveland, T. (2009). Teaching design in television production technology: The twelve steps of pre-production. *The Technology Teacher*, *68*(8), 17-23.

Loveland, T., & Harrison, H. L. (2008). Producing television commercials in high school technology education: An authentic standards-based project. *The Technology Teacher*, *68*(3), 5-12.

International Technology Education Association. (2008). Research supporting technology education. Reston, VA: Author.

Harrison, H. L. (2006). Broadcast communications in the educational setting. *TIES Magazine*. Fall/Winter 2006, 16-22.

Loveland, T., & Harrison, H. L. (2006). Video production: A new technological curricula. *The Technology Teacher*, *66*(3), 7-13.

Peterson, R. E., & Harrison, H. L. (2005). The created environment: An assessment tool for technology education teachers. *The Technology Teacher*, *64*(6), 7-10.