LEARNING STRATEGIES OF SECONDARY SCHOOL TECHNOLOGY EDUCATION TEACHERS AND THEIR STUDENTS

by

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Liberty University

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ABSTRACT

The United States has long been known as a nation of innovators and doers, supported by an educational system based on these concepts; however, our school systems have had problems producing students prepared to retain the United States as a global leader. Technology Education is an exception. Technology Education provides the opportunity to apply knowledge, theory, and concepts to real-world applications through the use of activities that encourage innovation and creativity. This study used a quantitative causal comparative design to investigate the learning strategies of secondary school Technology Education teachers and their students, distribution of learning strategies in the Technology Education courses, and the differences in learning strategies across the International Technology and Engineering Educators Association (ITEEA) program areas. Technology Education teachers and students in selected programs across Virginia took the Assessing the Learning Strategies of Adults (ATLAS) instrument, which placed them in a learning strategy category of *navigator*, *problem solver*, or *engager*, and completed a short demographic survey about gender, Technology Education program, grade, and age. A Chi Square Test of Independence was used to see if there were significant differences in the learning strategies of Technology Education teachers and their students, and also if there was a significant difference in learning strategies among the ITEEA program areas. It is hoped that this study will provide insight into the learning strategies in Technology Education so that programs and curriculum can be developed that improve the overall effectiveness of the instructional process.

Keywords: Technology Education, ITEEA program area, learning styles, learning strategies, ATLAS.

Dedication

This study is dedicated to all of the people that have inspired me to complete this long journey through the dissertation maze. Almost ten years ago my wife, Jan, encouraged me to go for my career ambition of obtaining a doctorate and she has been a support ever since. I thank all of the friends, colleagues, and professors that have provided advice and reassurance along the way. And I thank God for the strength and skills to make this a reality.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Assessing the Learning Strategies of Adults (ATLAS)

Career and Technical Education (CTE)

International Technology and Engineering Educators Association (ITEEA)

Standards for Technological Literacy (STL)

Virginia Technology and Engineering Educators Association (VTEEA)

Virginia Department of Education (VDOE)

CHAPTER ONE: INTRODUCTION

Overview

The purpose of this study was to determine if the proportions of *navigator, problem solver,* and *engager* learning types are the same for secondary school Technology Education students and their teachers. Chapter One will present an introduction to the problem, and provide relevance as to how this research relates to the problem. The problem statement, purpose, and significance of this study will be presented and discussed, and definitions related to the study will be provided.

Background

Students entering school are learning and training for jobs in a global marketplace, and the U.S. Bureau of Labor (2017) predicts that approximately 65% of these jobs have yet to be created. Rapid changes in technology have changed the skill requirements for most jobs, and technology has either greatly changed many occupations or made them extinct (Korzep, 2010). There is a “skills gap” in the United States, with millions of jobs going unfilled because there are not enough people with the necessary skills to fill them (Cappelli, 2012). Educators have a daunting task ahead of them to teach skills that will allow students to solve problems that have not been encountered before and will not be seen for years (Cappelli, 2012). With the constantly changing requirements of the job market, it is important that students have a baseline of skills that they can build upon, as they will likely be reskilled throughout their career (Groen, 2012). With technology being the driving force behind most of the change in the job market, Technology Education is the logical choice for students to build a baseline of skills in the technologies that will be the foundation for their future career (Sanders, 2009).

A key component to creating the academic success needed to fill the highly technical jobs of the future is the motivation to learn (Bell & Blanchflower, 2011). A Johns Hopkins study found that the strongest determinant as to whether or not a student finishes an assignment is *utility*, with utility being how close the assignment is matched to what is useful in the real world. The study also found that the most significant predictor of effort is the degree of intrinsic interest in the assignment (Balfanz, Herzog, & MacIver, 2007). By 2025, 65% of the new jobs being created will require some degree of post-secondary training or education, compared to 28% in 1973 (U.S. Bureau of Labor, 2018). It is imperative that students at the secondary level are motivated to stay in school and to be successful so that they are prepared to enter post-secondary education.

One way to maintain or increase motivation in secondary school students is the use of individual learning strategies to develop differentiated learning activities for students. The Assessing the Learning Strategy of Adults (ATLAS) instrument is a tool for assessing the learning strategy of secondary school students. The ATLAS instrument places students into a *navigator, problem solver,* or *engager* learning strategy category (Conti, 2009). Each category of learning strategies provides the student with a profile of learning preferences that are common in his or her group and can be utilized to increase motivation. Metacognition increases motivation by making students aware of their learning strategies, so they can learn how and when to use their preferred learning strategy when faced with different learning problems (Ausburn & Brown, 2006). When teachers are aware of their students' preferred learning strategies and use the data to differentiate instruction, motivation is increased (Mullan, 2011). A motivated student has higher achievement levels as well as a positive impact on the classroom environment, which is another factor for improved motivation (Eyal & Roth, 2011).

The concept of students being individuals with unique wants and needs has been a topic of educational research since at least the early 1900's (McCauley, 2000). The topic of learning styles and how they influence student success has been a theme of study in education beginning with the work of Carl Jung in the 1920s on how people perceive their environment differently (Heuer, 2001). Not only have researchers attempted to confirm that learners are unique individuals, they have attempted to place learners into distinct categories of learners (Keirsey & Bates, 1984). Research has suggested that students can be placed into broad categories according to how they prefer to learn (Dunn & Dunn, 1978). It is generally accepted by educators and cognitive scientists that there is a difference between learners, and that addressing these differences through modified classroom activities, results in increased in academic performance (Riener & Willingham, 2010). Since this early research on perception, volumes of research has been performed that has consistently shown that there is a positive relationship on student achievement when teaching strategies are aligned with the learning styles of students (Schleicher, 2011). ATLAS theory is a tool that is used to place students into learning theory categories using real-world problems and scenarios (Conti, 2009).

Just as learning style theory has changed greatly since the early 1900's, so has the role of Technology Education in American schools (Gordon, 2003). At its inception in the early 1900's, Technology Education, which was then called Manual Training, was physically and philosophically separated from mainstream academic instruction (Gordon, 2003). Since Technology Education is a direct reflection of the technology used in business and industry, the role of Technology Education has changed with the increasing complexity of technology since its inception as Manual Training (Friedel, 2011). Jobs in business in industry now require a strong base in the traditional academic areas as well as knowledge of technological systems, so the line has become blurred between academics and Technology Education (Cappelli, 2012). Over time Technology Education has become part of the core academic standard.

ATLAS is based on the work of Conti and Kolody (1995, 1999, 2004), and Fellenz and Conti (1993). Their theory is based on and follows the concepts of other learning styles research, in that students are placed into a learning strategy category that is meant to reflect the way a person prefers to approach a learning task, which in turn reveals their instructional needs (Conti, 2009). The learning strategy categories developed by Conti and Fellenz (1993) and Conti and Kolody (1995, 1999, 2004) represent broad categories of learning activities that people use in a variety of activities and learning situations. Thus, they can be applied to a wide variety of learning experiences. The ATLAS instrument places students into one of three categories of learning strategies that are alternative approaches to learning: *Navigators*, *Problem Solvers*, or *Engagers.* Each of the three learning strategy categories has a detailed description of the techniques or skills that a learner would use to approach a learning task (Conti & Kolody, 1999). The ATLAS instrument has been used with a variety of adult learners, secondary Technology Education students, and also secondary and adult Career and Technical Education (CTE) students (Ausburn & Brown, 2006). One of the reasons it is highly relevant for Technology Education is that ATLAS is based on real-world problems and not the theoretical content that is found in many classes outside Technology Education (Fazarro, Pannkuk, & Pavelock, 2009).

Problem Statement

Ausburn and Brown (2006) researched the relationship between learning strategies and the instructional preferences of CTE students, including Technology Education students, and found the students in their study had a predominant learning strategy categorized as "*engager,*" which varied from the general population. This result was suggested using the results of an instrument named Assessing the Learning Strategies of Adults (ATLAS) developed through the research of Conti and Kolody (2004). This research suggested that CTE and Technology Education students may have a preferred learning strategy that is different from the general population, allowing teachers to develop curriculum specifically targeting Technology Education students (Ausburn & Brown, 2006). Research has suggested that students who are self-aware of their learning strategy, using instruments like ATLAS, have higher achievement than students that are not aware of their preferred learning strategy (Schleicher, 2011).

Ausburn and Brown (2006) recommended that the study of learning strategies be focused on more specific CTE areas such as Technology Education, and that more research was needed in identifying the learning strategies of Technology Education teachers as well as students. To date, there is a lack of published research in these areas. The problem is that there has not been adequate research identifying and comparing the learning strategies of Technology Education teachers and their students using the ATLAS model.

Purpose Statement

The purpose of this causal comparative study is to see if the proportions of *navigator, problem solver,* and *engager* learning types will be the same for secondary school Technology Education students and their teachers. According to Gall, Gall, and Borg (2010), a causal comparative study is appropriate because the independent variables are naturally occurring and cannot be manipulated with controlled experiments, making an ex post facto design the best way to examine the comparison groups. The ATLAS instrument will be used to determine the preferred learning strategy. The study will also identify and compare the learning strategies of secondary school Technology Education teachers and their students taking classes in the different areas of Technology Education identified by the International Technology Education and Engineering Educators Association (ITEEA). ITEEA has identified seven areas of study that should be taught in Technology Education: Medical Technologies, Agricultural and Related Biotechnologies, Energy and Power Technologies, Information and Communication Technologies, Transportation Technologies, Manufacturing Technologies, and Construction Technologies (ITEEA, 2007).

The independent variables are *Technology Education teacher* and *Technology Education student. Technology Education teacher* will be formed using secondary Technology Education teachers in Virginia that are teaching a secondary level course in grades 8 through 12, including dual enrollment courses. *Technology Education student* will be formed using secondary Technology Education students in Virginia that are taking a secondary level course, and are in grades 8 through 12, including dual enrollment students. The dependent variables for this study will be the learning strategy: *navigator learning strategy*, *problem solver learning strategy*, and *engager learning strategy*. The dependent variables learning strategy (*navigator learning strategy*, *problem solver learning strategy*, and *engager learning strategy)*, will be determined using the ATLAS instrument, which places participants into *navigator, problem solver,* or *engager* learning strategy groups. The sample will be drawn using a convenience sample of 632 teachers and approximately 12,000 students that were participating in a secondary school Technology Education course in Virginia in the spring semester of 2019.

Significance of the Study

There have been numerous studies on learning preferences that suggest the identification of learning preferences and their use in curriculum design can have a positive impact on student academic success (Berry & Settle, 2011; Brady, 2013). Studies have suggested that students who receive instruction in a way that is compatible with their learning preference tend to have better grades in class assignments, and also overall grades for the course (Fazarro, Pannkuk, & Pavelock, 2009). Studies of Technology Education classrooms have shown that when students are aware of their preferred learning strategy, they are able to process information in a way that relates to their learning strategy. Thus achievement is higher for these students than a control group that was not aware of their learning preference (Ausburn, Martens, Washington, Steele, & Washburn, 2009).

Learning strategies can also be used for curriculum development. When teachers are aware of the preferred learning strategies of students, they can differentiate instruction for that student and/or provide alternatives for evaluating mastery that meet several different learning strategy preferences (Duhaney, 2012). Identification of preferred learning strategies could also be an aid for guidance personnel to make informed decisions when placing students in different pathways of study, which increases the likelihood of student success and motivation to stay in the classroom (Shearer, 2009)

There have been numerous studies on the relationship between learning strategies and education in general, but there is very little research concerning the learning strategies of students in relation to their Technology Education teachers. The ATLAS model and instrument has been used in over 50 dissertations and 20 or more journal articles; however, it has not been used extensively in studies that compare students and teachers, and there are no known studies that specifically use Technology Education (Conti & McNeil, 2011). This study is intended to add to the existing body of knowledge in the field of learning strategies by identifying and comparing the preferred learning strategies of secondary school Technology Education teachers and their students.

Research Question

RQ1: Will the proportions of *navigator*, *problem solver*, and *engager* learning types be the same for secondary school Technology Education students and their teachers in various Technology Education program areas?

Null Hypotheses

$H_0$1: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers for the *overall* ITEEA program areas.

$H_0$2: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Medical Technologies* program area.

$H_0$3: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Agriculture and Related Biotechnologies* program area.

$H_0$4: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Energy and Power Technologies* program area.

$H_0$5: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Information and Communication Technologies* program area.

$H_0$6: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Transportation Technologies* program area.

$H_0$7: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Manufacturing Technologies* program area.

$H_0$8: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the *Construction Technologies* program area.

Definitions

1. *ATLAS* – An acronym for the Assessing the Learning Strategy of Adults theory and instrument. It is used to determine an individual's preferred learning strategy (Conti, 2009).
2. *Career and Technical Education (CTE)* – Sometimes referred to as vocational education, CTE is a series of courses that works with academic courses to prepare students for future educational opportunities. Technology Education is a program of study in CTE (NASDCTEc, 2014).
3. *Differentiated Instruction* – A teaching technique that incorporates instruction matched to the learning needs of each student, maximizing student learning potential and performance (Santangelo & Tomlinson, 2012).
4. *ITEEA* – The International Technology and Engineering Educators Association. A primary goal of the organization is to prepare students to work and live in a technological world (ITEEA, 2014).
5. *Learning Style* – How an individual prefers to acquire or process information developed through experiences with learning. Also referred to as learning preference, cognitive style, and cognitive preference (Berry & Settle, 2011).
6. *Learning Strategy* – Based on learning style theory, a learning strategy is a preferred instructional technique that can be applied in most learning contexts (Conti & Kolody, 1998).
7. *Metacognition* – The awareness and understanding of a person's own thought process. It includes knowing what learning strategies to use when confronted with a learning problem and how to use the strategies (Ausburn & Brown, 2006).

8. *Reskilled* – The process of learning new skills as different technology is required to perform a task or job (Groen, 2012).
9. *Skills gap* – Having jobs that cannot be filled because there are not enough qualified workers for the job (Cappelli, 2012).
10. *Student Directed Learning* – A method of presenting learning content where students choose what learning activity to use, normally using alternative assignments provided by the teacher (Saltman, 2012).
11. *Technology Education* – A program in CTE that prepares students for entry into postsecondary education and into career fields related to technology (Virginia Department of Education, 2019f).

CHAPTER TWO: LITERATURE REVIEW

According to Howard Gardner (2011), each student possesses unique intelligences, and prefers certain types of instruction to other types. This concept of students being unique individuals with unique wants and needs has been a topic of educational research since at least the early 1900's (McCauley, 2000). The topic of learning styles and how they influence student success has been a theme of study in education beginning with the work of Carl Jung in the 1920's on how people perceive their environment differently (Heuer, 2001). Not only have researchers attempted to confirm that learners are unique individuals, they have attempted to place learners into distinct categories of learners (Keirsey & Bates, 1984).

This attempt has drawn criticism from some educational researchers. Considering the unique nature of each student, there is some concern that placing students into a category is an oversimplification of a very complex phenomenon (Pashler, McDaniel, Rohrer, & Bjork, 2010). However, research has suggested that students can be placed into broad categories according to how they prefer to learn (Dunn & Dunn, 1978). It is generally accepted by educators and cognitive scientists that there is a difference between learners, and that addressing these differences through modified classroom activities can result in increased academic performance (Riener & Willingham, 2010). Researchers have used several terms to categorize students into different types of learners using terms such as learning styles, learning preferences, cognitive styles, and learning strategies (Ausburn & Brown, 2006).

A current terminology for individualized instruction is differentiated instruction. Differentiated instruction is providing different paths for students to achieve by taking into account the students' abilities or interests (Dixon, Yssel, McConnell, & Hardin, 2014). Regardless of the terminology for the way students prefer to learn, each term is an attempt to group students using characteristics that reveal how they prefer to acquire knowledge or solve problems. The instructor then utilizes this information to improve instruction and achievement using student centered instruction. Since Jung's early research on perception, volumes of research has been performed that has consistently shown that there is a positive relationship on student achievement when teaching strategies are aligned with the learning preferences of students (Schleicher, 2011).

Theoretical Framework

Most of the modern learning styles and learning strategies theories are based on the work of Carl Jung, a Swiss psychiatrist who founded analytical psychology. Starting in the 1920s, Jung noted differences in how people perceived phenomenon, mainly through sensation or intuition. He also explored the way people made decisions, whether by logical thinking or imaginative feelings, and how extroverted or introverted they were while interacting with each other (Heuer, 2001). Jung's work with individual differences led to the separation of individuals by psychological type, and his theories allowed the grouping of individuals by the way they perceived phenomenon and made judgments. Since grouping individuals by a common learning preference is a requisite for learning styles research, this was an important step in exploring the way people preferred to learn (Jung, 1961). Jung separated people into four psychological types: sensation, intuition, thinking, and feeling. Jung theorized that a person's psychological type, "from the outset determines and limits a person's judgment" (Jung, 1961, p. 207). Although people use all four psychological functions when encountering different situations, one of the functions is more dominate, and consciously used more (Jones, 2003).

Building on Jungian theories of grouping people into psychological types, the Myers-Briggs Type Indicator was developed in the 1950's. The Myers-Briggs Type Indicator used the four personality functions developed by Jung and expanded them into 16 different personality types (McCauley, 2000). Keirsey and Bates (1984) used the Myers-Briggs 16 personality types to identify four categories of learning styles, grouping people according to the instructional techniques that the groups preferred when approaching learning tasks. The Dunn and Dunn learning styles model organized people into five groups based on 21 elements of learning: environmental, emotional, sociological, physical, and psychological. These groups were then combined to determine a learning style that could be used in a broad area of learning tasks (Dunn & Dunn, 1978). These were not the only researchers in this time period developing learning styles based on Jungian theory, however they helped to bring the theory of psychological types closer to application in the field of education.

ATLAS Theory

Research with the learning strategies of adults started with the work of Dr. Robert Fellenz, with the assistance of the research team at the Kellogg Center for Adult Learning Research at Montana State University (Conti & McNeil, 2012). The research team identified five areas that they theorized to be part of adult learning strategies: Metacognition, Metamotivation, Memory, Critical Thinking, and Resource Management (p.2). Metacognition is the realization of ones thinking and learning process, and the ability to self-direct the learning process using planning, monitoring, and adjusting strategies (Conti & McNeil, 2012). Metamotivation is the awareness of the factors that motivate and direct an individual’s learning, including the ability to control these factors. Metamotivation has three stages: Attention, Reward/Enjoyment, and Confidence (Conti & McNeil, 2012). Memory deals with the mental processes of learning including how information is stored, retained, and retrieved. Memory also includes strategies to organize information, the use of external aides to improve learning, and methods to retrieve stored information (Conti & McNeil, 2012). Critical thinking is a “reflective thinking process” (p. 2), where the learning is enhanced using the strategies of Testing Assumptions, Generating Alternatives, and Conditional Acceptance (Conti & McNeil, 2012). Resource Management is the process of identifying what resources are most relevant to the learning task, using the strategies of Identification of Resources, Critical Use of Resources, and use of Human Resources (Conti & McNeil, 2012, p. 3).

Contemporary research on student’s preferred approach to learning has taken on different names, mainly in an effort to reflect the researcher’s learning theory. Some common terms are learning styles, learning preferences, and learning strategies, with cognitive used in place of learning in some research (Ausburn & Brown, 2006). Ausburn, alone or in partnership with other researchers, has authored at least seven journal articles relating cognitive (learning) strategies with instruction related to Career and Technical Education and Technology Education in which there was a positive relationship between learning strategies and learning achievement (Conti, 2009). In the 1980s Gary Conti began a series of research that studied the relationship between teaching style and how adult students learn, which was the start of Conti’s research with learning strategies and adult learning that continues to the present (Conti & Welborn, 1986). Over the period from 1986 to present, Conti and Fellenz (1991), and Conti and Kolody (1998) developed the theory behind Assessing the Learning Strategies of Adults (ATLAS), which is built on learning strategy theory. ATLAS is both a learning strategy theory and also an instrument to measure preferred learning strategy, developed by Fellenz and Conti (1989, 1993), Conti and Kolody (1995, 1998), and Conti (2009).

Learning strategies is the term used by Conti, Fellenz, and Kolody, the researchers that developed the ATLAS learning strategies theory (Conti & Kolody, 1995; Fellenz & Conti, 1993). Learning strategies research grew out of the desire to teach study skills techniques to students in higher education, and the concept is rooted in the idea that learning strategies are related to practical application of real-world problems and technology (Conti & McNeil, 2012). ATLAS research also proposes that adult learning is a learner-centered experience and that learning strategy preferences are a way identify individual differences (Conti & McNeil, 2012).

Conti and Kolody (2004) expanded their earlier work with learning strategies and developed an assessment instrument named Assessing the Learning Strategies of Adults. The primary difference in the Conti and Kolody (2004) theory and previous theory is that learning styles are fixed internal traits that a person uses in different learning tasks and instructional methods, whereas learning strategies are real world skills or techniques that are applied to specific learning tasks and instructional methods that can be taught by an instructor. Ausburn and Brown (2006) conducted research using ATLAS with Technology Education students as participants, which is one of the few studies with Technology Education students that has been published in a peer-reviewed journal. Although the model and learning strategy instrument address adult learning, the instrument has been widely used with secondary students, with the concern that students younger than the secondary level have had fewer learning experiences, and their learning strategies may be still evolving at a rapid pace (Shaw, Conti, & Shaw, 2013).

ATLAS Learning Strategy Types

The ATLAS instrument is based on the ATLAS theory of learning strategies, and separates learners into three categories: *engagers, navigators*, or *problem solvers* (Conti, 2009). Dr. Conti (2009), one of the predominate researchers in learning strategies research, summarized the difference between *engagers, navigators,* and *problem solvers*:

> The Navigators are microscopic as they narrow, focus, and zoom in on the learning task. Problem Solvers, on the other hand, are telescopic as they zoom out to include as large a field as possible in their learning. Engagers are stethoscopic with their feelings from the heart and concern for relationships. (p. 893)

Engager

An engager is the type of student that loves to learn and brings a passion to learning. They like to be engaged with the classroom assignment, the teacher, the subject matter, and the environment around them (Conti, 2009). Engagers like to approach a problem or learning task using the affective domain, in that they like to internally reflect as to whether the assignment will be enjoyable and/or worth the effort to complete (Ghost Bear, 2001). Emotion is an important aspect of engagers. They express their emotion in their ability to build relationships with others, and also through the use of emotional words such as “love and fun” (Conti, 2009, p. 894). Engagers find learning appealing when they relate to a learning task, and they tend to fully immerse themselves in the assignment, taking enjoy mastery of a new concept (Conti, 2009).

Engagers can also become bored easily (Conti, 2009). The instructor must keep them actively engaged in the learning process and remember that for engagers the process of learning and the relationships involved are as important as the final learning outcome (Ausburn & Brown, 2006). They are not interested in learning new or complex ways of achieving solutions. Engagers like to use shortcuts and take the easier route to solving a learning task, as the quicker they get through the mundane tasks of the process the more time they have for exploring the learning process and interacting with others (Conti, 2009). Since engagers like to interact with others, teachers should try to let them work in groups, or incorporate cooperative learning, if it is feasible for the task to be completed by more than one person. Engagers also desire to have a positive working and emotional relationship with their teacher, so providing attention and support to an engager help keep them motivated to learn (Shaw, Conti, & Shaw, 2013).

Navigator

Navigators approach a learning task by looking at all the options that are available to solve the problem, and then they eliminate the weaker options and focus on techniques they think will be effective. They tend to be focused learners that devise a plan and stick to it (Ghost Bear, 2008). Unlike engagers, they look for external solutions to problems. They look to the learning environment to find learning techniques that are efficient and effective (Conti, 2009). Navigators are continuously seeking ways to improve (Ausburn & Brown, 2006). According to Conti (2009), navigators have “a demand for order and structure, are logic oriented, are objective, and are perfectionists” (p. 893). Navigators do not value the emotional aspect of learning, tending to focus on seeing results and the logical aspects of an assignment.

Teachers should provide order and structure for navigators when developing their assignments and make sure all of the expectations are clear. This can be done by providing a detailed schedule with deadlines and an assignment organizer for the student to write the expectations on a calendar (Ausburn & Brown, 2006). Providing advanced organizers before starting a new learning activity and reiterating what was done at the end of class are helpful in providing the structure that navigators need (Conti, 2009). Organizing tools such as highlighters, notebooks, and three ring binders also help to keep navigators organized (Conti & McNeil, 2012). Navigators also expect prompt feedback from their instructor (Conti, 2009). They do not like group work unless there is an expert that they feel can direct the learning activity and contribute to the group. Navigators feel like they could do better work, and do it more efficiently, without working in a group (Conti, 2009). Navigators tend to be perfectionists, and put a lot of pressure on themselves to do exceptional work, even when the internal criticism may not be justified. Teachers need to give clear feedback as to how they are evaluating their work and reassure them when the work is meeting expectations (Ausburn & Brown, 2006).

Problem Solver

Problem solvers are somewhat like navigators in that they look for external learning strategies. However, instead of narrowing down the different resources, they tend to use the resources to develop alternative learning solutions (Conti, 2009). Problem solvers can be indecisive, with much of their learning time being devoted to developing new approaches to learning or searching for new learning solutions. One of the ways they make decisions is in telling stories. Through telling stories, problem solvers lay out their rationale for the learning strategy they ultimately choose (Ghost Bear, 2008). Problem solvers like to procrastinate because it gives them more time to come up with solutions (Conti, 2009). They also do not like to have the learning process interrupted because once they are distracted, it is hard to pick back up from where they were (Conti, 2009). Problem solvers tend to be, “curious, inventive, and intuitive” (Conti, 2009, p. 894).

Problem solvers generally do not do well on multiple-choice tests because they are limited to a certain number of solutions to the problem, so teachers should provide other avenues to express mastery that are not as limiting. This may include substituting short answer or essay questions for multiple-choice (Ausburn & Brown, 2006). To problem solvers, learning is an adventure, so they do not like rigid structure in the assignments. Instructors should allow some student-structured alternatives to achieve the desired objectives, as problem solvers tend to think in abstract symbols that may not match with teacher-structured or standardized tests (Conti, 2009). Problem solvers are also very descriptive, which does not work well with true-false and multiple-choice tests. Problem solvers are very confident in their abilities, and may ask questions or make comments to express their ideas (Conti, 2009). Teachers should allow problem solvers an opportunity to express their ideas in class.

Motivation to Learn

Motivation is a term that can be interpreted in many different ways. A simplistic definition describes motivation as something that initiates a behavior, provides a channel for the behavior, and/or maintains or stops a behavior (Saville & Holdsworth, 1995). Many theorists have modeled motivation as a dualistic concept where there is intrinsic motivation and extrinsic motivation. Intrinsic motivation is a behavior that is exhibited because there is an internal desire in an individual to perform it. Extrinsic motivation causes behaviors that are driven by some sort of reward, such achievement of a goal, or an incentive such as money or a promotion (Reiss, 2012). Although the line between intrinsic and extrinsic motivation is somewhat muddled, research has suggested that there is a separation between internal and external motivators.

Students that are intrinsically motivated are more apt to volunteer to undertake an activity and are more likely to learn more complex material effectively (Hennessey, 2015). Intrinsically motivated students also tend to engage in the assignment more deeply, persist at the task longer, and work with more vigor and intensity (Vansteenkiste, Lens, & Deci, 2006). Studies have also shown that by making education more student-centered (intrinsic), compared to the current high-stakes testing environment, learning can be improved and student engagement and creativity can be significantly increased (Hennessey, 2015).

Intrinsic motivation can come and go without warning, and no students are intrinsically motivated all of the time. The current rewards based system of education using evaluation, surveillance, competition, etc. does not foster continued motivation (Vansteenkiste, Lens & Deci, 2006). Studies have shown that reward based motivation is not an effective way to motivate students over a period of time, and the motivation disappears when the motivation is taken away (Kitayama & Markus, 1994). Motivation is not caused by a singular event but by a combination of factors. What motivates one student may not motivate another student or actually decrease motivation (Gee, 2004). The classroom environment, including the instructional strategies used, is a major determinant of a student's motivation (Hennessey, 2015). Motivation in itself is not the solution for increasing student achievement. If learners are motivated but the instructor is not capable and/or does not provide quality instruction, then learning does not occur (Wlodkowski & Ginsberg, 1995).

The ATLAS theory of learning strategies is focused on the intrinsic motivators that determine how students prefer to learn material, and thus provide educators with concrete teaching tools that make instruction student-centered, which then increases student motivation and achievement (Conti, 2009). One of the concepts of ATLAS theory is metamotivation, which is a term used by Maslow (1971) as part of his Hierarchy of Needs theory. Maslow theorized that once a person fulfilled their lower-level needs they become self-actualized and are intrinsically motivated to perform a task, duty, or job that they enjoy (Engler, 2009). In ATLAS theory, metamotivation is the awareness and control over factors that motivate and direct an individual's learning process, (Conti, 2009). These factors are attention, reward/enjoyment, and confidence.

Attention is a motivating factor in that students can use their preferred learning strategies as a tool to solve problems, making learning more self-directed and allowing students to use strategies that they are familiar and proficient with. Reward/enjoyment is the anticipation of personal reward that completing a task will provide, and also the enjoyment of participating in a learning activity that is fun and satisfying. Confidence is believing that the learning activity is worth doing, and also a task that the learner can complete (Keller, 1987).

Learning Strategies and Technology Education

Learning strategies research attempts to group students by their preferred instructional methodology. Student responses to a survey/instrument place him or her into a category that identifies the student as belonging with a cluster of students with similar characteristics. These characteristics may include how a student acquires knowledge, processes information, approaches problem solving, or prefers particular instructional methodology (Conti, 2009). Theories on learning styles tend to focus on cognitive processes such as sensory learning, (special, auditory, linguistic), the approach a person takes (mathematical or kinesthetic), or interaction with others (interpersonal or intrapersonal) (Rolfe & Cheek, 2012). A major difference between learning styles theory and learning strategy theory is that learning styles are traits that a learner brings to multiple learning situations, whereas learning strategies are techniques that are used to address a specific task (Conti & McNeil, 2012). There many learning styles theories available with accompanying learning style inventories, and each lends to the body of knowledge in the field of student-centered instruction in their own way. Learning strategy theory uses some aspects of learning styles theory, however learning strategies are a separate field of study.

Learning strategy research differs from the better known learning styles research in that the emphasis is on the skills or techniques that a learner chooses to solve a problem (Conti & McNeil, 2012). Understanding learning strategies is useful to instructors in that they can tailor instructional practices to the needs of the individual learner (Conti, 2009). Learning strategies theory can also be used for curriculum and instructional planning, in that the ATLAS instrument identifies the learning preferences of students (Ausburn & Brown, 2006). Since learning strategies are techniques for learning and not the internalized cognitive traits of learning styles, they can be taught to students (Conti & McNeil, 2012). Not only can the instructor modify the curriculum to meet the existing preferred learning strategies of students, they can also teach students new strategies for processing information (Ausburn & Brown, 2006). Additionally, when students are allowed to demonstrating knowledge of a concept or objective using assessments that match their learning preference, mastery of the material is enhanced (Lehman, 2011). Awareness of student learning strategy also provides guidance for teachers to design assignments that allow student choice, or student directed learning, which has been shown to increase motivation to learn and student achievement (Schleicher, 2011; Deci, 2002). One option to assess the learning strategies of students is by using the ATLAS theory.

The Assessing the Learning Strategies of Adults (ATLAS) theory, and the companion assessment, is a newer development in the field of student-centered instruction. ATLAS is grounded on previous research on individual differences, and the various psychological types of students (Conti, 2009). A major precept in the ATLAS model is that learning styles are inherent traits of individuals that are used to in multiple learning situations, whereas learning strategies are skills and techniques a learner uses to address a learning task (Fellenz & Conti, 1989). Since learning strategies can be taught, instructors can develop teaching strategies that help students attain the desired learning objectives (Ausburn & Brown, 2006). Another principle of ATLAS is that learning strategies must be related to real-world problems in order to be assessed (Conti, 2009). Technology Education may be an appropriate discipline for applying ATLAS theory since the curriculum is based on real-world technologies and problems.

Technology Education teachers and students are appropriate subjects for using ATLAS theory since Technology Education is focused on developing a workforce using instruction related to real-life scenarios in the workplace (U.S. Department of Education, 2019). This real-life application of instruction directly relates to the ATLAS principle of learning strategies being linked to real-world problems. The Virginia Department of Education (2019) defines one of the goals of Technology Education to be “Discover and develop personal interests and abilities related to a wide variety of technology-oriented careers,” which correlates with ATLAS learning strategy theory (p. 1). Also, Technology Education is not career specific, so instruction is directed at multiple career areas (Virginia Department of Education, 2019f). Using Technology Education courses with ATLAS theory allows teachers and students to be linked to multiple career pathways, which are reflected in the International Technology and Engineering Educators Association (ITEEA) program areas. Technology Education has middle school and secondary levels, and Virginia has 86 approved secondary school Technology Education courses (Virginia Department of Education, 2019b).

In the early stages of learning strategy research, Technology Education was included as part of education as a whole, and little or no research was conducted specifically relating learning styles and Technology Education (Fazarro, Pannkuk, & Pavelock, 2009). Ausburn and Ausburn (1978) were two of the first researchers to investigate learning strategies, which they termed cognitive styles. L.J. Ausburn’s (1976) research focused on the cognitive style factors of college students and how these factors related to students’ perception of instructional strategies. Ausburn concluded that individuals have distinct cognitive styles, which can be categorized by the way they process information. These cognitive styles are stable traits that are resistant to change and not related to an individual’s ability. Ausburn and Ausburn (1978) used to the results to advocate the use of alternative instructional techniques for students that had trouble mastering learning material or a specific task using the instructor-provided learning methodology. They determined that when instruction is matched with the preferred cognitive style of the student, the needs of the individual learner are met, and student achievement is improved. Ausburn and Ausburn continued their work in learning strategies, utilizing the ATLAS instrument to place learners into *navigator, problem solver,* or *engager* learning strategy groups.

Ausburn and Brown (2006) were the first researchers to use ATLAS to determine the learning styles preferences of Career and Technical Education (CTE) students, which includes Technology Education students. Ausburn and Brown (2006) administered the ATLAS instrument to 617 CTE students in 13 different program areas, finding that CTE students had a statistically significant proportion of *engagers* (45.4%) compared to the expected proportion (31.8%). The proportion of *problem solvers* (30.3%) was similar to the expected norm (31.7%), and the proportion of navigators (24.3%) was lower than the expected norm (36.5%). Ausburn and Brown (2005) conducted two follow-up studies involving CTE students using identical methodology. The first study involved 46 CTE students that had ATLAS results of 15.21% *navigators,* 17.39% *problem solvers,* and 67.4% *engagers*. The second study involved 251 CTE students that had ATLAS results of 26% *navigators*, 27% *problem solvers*, and 47% *engagers*. The two follow-up studies confirmed the original findings that the proportion of CTE students with an *engager* learning style was significantly higher than what is normally found in the general population.

Ausburn and Brown concluded that CTE classes have a significantly higher proportion of engager students in their classrooms compared to the general population. These results align with other ATLAS studies using nontraditional students, which are students that do not fit the traditional high school to baccalaureate tracks (James, 2000; Massey, 2001; Willyard, 2000; Shaw, 2004). This may suggest that engagers are a type of learner that tend to leave conventional secondary education and traditional post-secondary education, and instead take CTE programs (Ausburn & Brown, 2006).

The data suggest that CTE teachers can enhance the learning environment by providing "hands-on learning activities, clear explanations, multiple learning resources, active rather than passive learning, applied learning related to real-life experience, meaningful learning assignments and projects, and personal rather than formal learning environments" (Ausburn & Brown, 2006, p. 32). These types of instructional strategies are often missing in traditional education tracks. With the mix of learning strategies, CTE teachers need to incorporate specific techniques for personalized instruction and also general instructional techniques that engage students across the three learning strategy types (Ausburn & Brown, 2006).

ATLAS has been utilized in at least seven journal articles, and in over 50 dissertations. There has not been any research found using ATLAS directly with Technology Education teachers or students. The Ausburn and Brown (2006) research is the most comprehensive in regards to CTE, however it does not involve CTE teachers. A study by McCaskey (2009), performed as part of a doctoral dissertation, studied the ATLAS learning strategies of CTE instructors in Illinois. Analysis of the ATLAS results found 115 (33.9%) were *navigators,* 157 (46.3%) were *problem solvers*, and 67 (19.8%) were *engagers*. McCaskey broke down the data by CTE area and found that the Technology Education teacher group had 19 *navigators* (21.59%), 55 *problem solvers* (62.5%), and 14 *engagers* (15.91%). In the McCaskey study, it was concluded that the proportion of CTE teachers and Technology Education teachers with a *problem solver* learning strategy was significantly higher than the general population.

McCaskey (2009) found that the proportion of CTE teachers with the *problem solvers* learning strategy (46.3%) was significantly higher than expected in the general population (31.7%). The study also determined that Technology Education teachers had an even higher proportion of *problem solvers* (62.5%). Technology Education teachers both had significantly lower proportions of *navigators* (21.59%) and *engagers* (15.91%). McCaskey (2009) attributed the higher proportions of *problem solvers* to the fact that *problem solvers* prefer to learn through practical experiences and hands-on activities, which are common teaching techniques in CTE and Technology Education. MaCaskey (2009) also attributed the higher number of *problem solvers* to the assumption that CTE are generally have a constructivist teaching philosophy that is consistent with the *problem solver* learning strategy.

International Technology Education and Engineering Educators Association

The Technology Education curriculum applies concepts in math, science, technology, and engineering to solve real world problems, using both cognitive and manipulative learning strategies (International Technology and Engineering Educators Association [ITEEA], 2019). The application of knowledge to real-world relevance and the acquirement of in-depth understanding to solve problems are characteristics of Technology Education that set it apart from other academic areas (Drage, 2009). One of the most influential associations driving Technology Education is the International Technology and Engineering Educators Association (ITEEA).

A mission of ITEEA is to provide peer reviewed publications geared toward the Technology Education community, and one of these publications is the Standards for

Technological Literacy: Content for the Study of Technology, commonly referred to as STL (ITEEA, 2007). The standards for technological literacy were developed over a period of three years by a diverse group of experts from both the educational and scientific community. The standards were developed using an extensive review of six drafts by over 4,000 people working in technology education or technology related fields (ITEEA, 2000). The STL publication identifies the content for K-12 labs and classrooms that is needed for students to become technologically literate, however STL is not a curriculum guide. The content includes real world application of knowledge through the use of both cognitive and performance-based activities. The standards also include assessments, with benchmarks provided, so students are on track to complete the standards at an age-appropriate time (ITEEA, 2007).

The Standards for Technological Literacy (2007) identified seven areas of study that should be taught in Technology Education classrooms/laboratories:

Medical technologies

Agricultural and related biotechnologies

Energy and power technologies

Information and communication technologies

Transportation technologies

Manufacturing technologies

Construction technologies

These seven areas of study group related Technology Education courses into clusters, providing a guide for students to select courses that explore different technologies. ITEEA has determined that a goal of Technology Education is for the student to understand the designed world, which are technologies that already exist and are applied in business and industry (ITEEA, 2007).

Each of the ITEEA standards for Technology Education describes how students should "select, use, and understand major technologies that are common today" (ITEEA, 2007, p. 14). The STL describes what students should know and also be able to do in order to be technologically literate in each of the seven technologies. The knowledge or cognitive aspect of the standard involves how the technology works and how it is used in the real world. The hands-on or process aspect of the standard describes the abilities the student should have in relation to the technology. Although cognitive standards and process standards are different, they do not stand alone, but rather complement each other to provide technological literacy in each technology area (ITEEA, 2007).

In Virginia, Technology Education is a distinct field of study under the broader field of Career and Technical Education. Virginia Technology Education has similar purposes and goals to ITEEA's in that the ultimate function is to develop technologically literate people (Virginia Department of Education, 2019f). The Virginia Department of Education (2019f) also emphasizes the cognitive and process aspects of Technology Education as students are encouraged to comprehend and apply the different aspects of technology as it relates to real-world innovations and careers. The Virginia Technology and Engineering Education Association (VTEEA) is an extension of ITEEA. VTEEA provides educational resources for Technology Education teachers through newsletters, conferences, program/staff development, and public relations (Virginia Technology and Engineering Education Association, 2019). The VTEEA's main purposes are to increase awareness of technology and engineering education programs, and to develop technologically literate society, which are consistent with ITEEA and the Virginia Department of Education (VTEEA, 2019). As previously discussed, the Standards for

Technological Literacy has identified seven areas of study that are in alignment with the Virginia standards.

Medical technologies.

The development of new medical technologies is allowing people to live longer and healthier lives. Existing medical technologies are being improved, and new technologies are being created at an extraordinary rate, making it important that Technology Education students understand the concepts of medical technology and how they are applied in society (ITEEA, 2007). Students should be provided with experiences that encourage exploration of existing technologies through hand-on activities, and also provide the opportunity to design and test new technologies (ITEEA, 2007). Students also learn about human anatomy and physiology, pathologies, diagnostic and clinical procedures, and the fundamentals of patient care (Virginia Department of Education, 2019e). The role of computers in healthcare should be explored as an aid to keeping track of patient's information and as a tool to analyze data for healthcare workers (ITEEA, 2007).

The Standards for Technological Literacy (STL) recommend that secondary school (grades 9 – 12) Technology Education students learn the following concepts in the Medical Technologies area:

a. Medical technologies include prevention and rehabilitation, vaccines and pharmaceuticals, medical and surgical procedures, genetic engineering, and the systems designed to protect and maintain health.
b. Telemedicine, which is used to diagnose and treat illness using computers or other communication technologies, is the convergence of a number of fields that include telecommunications, medicine, virtual reality, robotics, and artificial intelligence.

c. Biochemistry and molecular biology have made it possible to manipulate genetic information in living beings.

In the 2013-2014 school year, 9,388 students in Virginia took courses that were relevant to the Medical Technologies content area (Virginia Department of Education, 2019d). There are four secondary school Technology Education courses in the Medical Technologies content area that have been matched to the SLT standards by the Virginia Department of Education: Bioengineering, Biotechnical Engineering, Biotechnical Foundations in Technology Education, and Forensic Technology. See appendix J for course descriptions.

Agricultural and related biotechnologies.

Agriculture is the process of growing plants and animals for food, and it also supplies materials to produce products for fuel, chemicals, fibers, and other consumer products (ITEEA, 2007). Biotechnology has been in use for thousands of years; however, scientists have recently developed techniques to manipulate the genetic instructions of cells and living tissues. Biotechnology can be used to improve crop yields, improve the quality of farm animals, and improve the health of humans and animals (Parekh, 2004). In addition to the positive aspects of biotechnology, there are also concerns about the safety, ethics, and environmental impact of genetically modified plants and animals (Holland & Johnson, 2012). Technology Education students should have a basic understanding of biotechnology in order apply and manage the technologies in a way that maximizes results while at the same time minimizes the possible negative effects on the environment and mankind (ITEEA, 2007).

The SLT recommend that secondary school (grades 9 – 12) Technology Education students learn the following standards in the Agricultural and Related Biotechnologies area:

a. Technological advances in agriculture directly affect the number of people required to produce food. Human resources have shifted to the technologies required for food processing, including tools, machines, and processes.
b. There is a wide variety of specialized equipment and practices used in the production of agricultural products.
c. Biotechnology applies the principles of biology to produce a wide variety of commercial products and processes that go beyond agriculture. These include pharmaceuticals, medicine, energy, and genetic engineering.
d. Conservation is a way of controlling erosion, reducing sediment in waterways, and improving the efficiency of water usage.
e. The design and management of agricultural systems requires knowledge of artificial ecosystems and the effects of technology on the environment (ITEEA, 2007).

In the 2013-2014 school year, 11,571 students in Virginia took courses that were relevant to the Agricultural and Related Biotechnologies content area (Virginia Department of Education, 2019d). There are four secondary school Technology Education courses in the Agricultural and Related Biotechnologies content area that have been matched to the SLT standards by the Virginia Department of Education: Bioengineering, Biotechnical Engineering, Biotechnical Foundations in Technology Education, and Forensic Technology. See appendix J for course descriptions.

Energy and power technologies.

Energy and power are two technologies that work together, however they have characteristics that differentiate one from the other. Energy is the capacity to do work. Some sources of energy are renewable, such as bio-fuels, and some are non-renewable, such as the burning of fossil fuels. Students should investigate the different sources of energy, including dependence on fossil fuels and the use of alternative sources of energy (ITEEA, 2007).

Power is defined as the rate at which energy is transformed from one form to another to produce work. The technology used in power systems needs to take into account the abundance of the energy source, the impact on the environment, and the efficiency of the energy conversion process (Steffen & Weber, 2013). Students should study the efficiency of power technologies including energy conversion, storage, and thermal loss. The conservation of energy resources and the environmental impacts of power production should also be investigated (ITEEA, 2007).

The SLT recommend that secondary school (grades 9 – 12) Technology Education students learn the following standards in the Energy and Power Technologies area:

a. The Law of Conservation of Energy states that energy cannot be created nor destroyed; however, energy can be converted from one form to another.
b. Energy can be grouped into major forms: mechanical, thermal, chemical, radiant, nuclear, and electrical.
c. It is not possible to build an engine that does not produce energy waste in the form of thermal energy.
d. Energy resources are renewable and nonrenewable.
e. A power system must have a source of energy, a process for converting energy, and a load (ITEEA, 2007).

In the 2013-2014 school year, 36,691 students in Virginia took courses that were relevant to the Energy and Power Technologies content area (Virginia Department of Education, 2019d). There are five secondary school Technology Education courses in the Energy and Power

Technologies content area that have been matched to the SLT standards by the Virginia Department of Education: Energy and Power, Digital Electronics, Electronics Systems, Renewable Energies, and Sustainability and Renewable Technologies. See appendix J for course descriptions.

Information and communication technologies.

The communication of information has always been a necessity; however, with the advent of digital information storage and transfer, information is easier to access than any other time in history. A common model for communicating information includes an information source, a way of sending the information, a channel or mode for the information to be transferred, a way to receive the information, and feedback as to what information was received (Sanders, 1997). Noise is another component of the communication system that hinders clear communication (Sanders, 1997). The SLT indicates that secondary school Technology Education students should be aware of each aspect of the communication process and have hands-on experiences with each component of the process, with the primary emphasis being on the technology used in the transfer of information (ITEEA, 2007). Secondary students should also have experiences designing communication systems, evaluating the effectiveness of different communication systems, and selecting the appropriate mode of communication (ITEEA, 2007).

The SLT recommend that secondary school (grades 9 – 12) Technology Education students learn the following standards in the Information and Communications Technologies area:

a. Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.

b. Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine-to-machine.

c. Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.

d. Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.

e. There are many ways to communicate information, such as graphic and electronic means.

f. Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli (ITEEA, 2007).

In the 2012-2013 school year, 11,461 students in Virginia took courses that were relevant to the Information and Communication Technologies content area (Virginia Department of Education, 2019d). There are seven secondary school Technology Education courses in the Information and Communications Technologies content area that have been matched to the SLT standards by the Virginia Department of Education: Advanced Drawing and Design, Imaging Technology, Graphic Communication, Technology Assessment, Digital Visualization, Communication Systems, and Video and Media. See appendix J for course descriptions.

Transportation technologies.

Transportation is a basic necessity that is used by individuals for work and recreation, and also as a method for moving goods from production facilities to the marketplace. The transportation system is a complex network of subsystems such as ports, highways, and airports that in turn require other subsystems such as logistics, ships, automobiles, maintenance, etc.

(ITEEA, 2007). Transportation systems also include space exploration and technologies such as smart cars that are capable of driving themselves.

Technology Education students should have direct experiences designing, developing, using, and assessing transportation systems to gain a thorough understand of the technologies involved. They should also learn about the vital role transportation plays in business and industry, and how the economy relies on the efficient transportation of commodities. Students should also devise solutions to others factors related to transportation such as cost, efficiency, safety, and impacts on the environment (ITEEA, 2007).

The SLT recommend that secondary school (grades 9 – 12) Technology Education students learn the following standards in the Transportation Technologies area:

a. Transportation plays an important role in the operation of other technologies such as construction, manufacturing, agriculture, and communication.
b. Intermodalism is the use of different modes of transportation to move people and goods from one mode to another, such as connecting, highways, railways, and waterways.
c. Transportation methods and services have encouraged the population to move through the creation of a safe and efficient transportation network.
d. The design of intelligent transportation systems such as smart cars, and non-intelligent systems such as walkways, both depend on innovative processes and techniques (ITEEA, 2007).

In the 2013-2014 school year, 5,801 students in Virginia took courses that were relevant to the Transportation Technologies content area (Virginia Department of Education, 2019d). There are five secondary school Technology Education courses in the Transportation

Technologies content area that have been matched to the SLT standards by the Virginia Department of Education: Aerospace Engineering, Aerospace Technology, Geospatial Technology, Global Logistics and Enterprise Systems, and Power and Transportation. See appendix J for course descriptions.

Manufacturing technologies.

Manufacturing is the production of merchandise for use or sale, using raw materials that are transformed into finished goods. This transformation is done using labor, tools, chemical and biological processing, and other formulation methods. Manufacturing has changed tremendously in the past century with the switch from custom made goods to mass-produced goods made possible with the development of automation, assembly lines, and standardized parts (Ellram, Tate, & Peterson, 2013). The development of additive production processes using 3D printing systems continues to change the way products are manufactured.

Technology Education students should learn that manufacturing can be classified into separating, forming, combining, and conditioning operations. They should have experiences using tools, materials, and processes in order to design, make, and assess different products. Students should also learn how to alter, install, service, and maintain products. They should be aware that many manufactured items have a limited life expectancy that has contributed to consumers throwing away products and buying new ones, creating large amounts of waste (ITEEA, 2007).

The SLT recommend that secondary school (grades 9 – 12) Technology Education students learn the following standards in the Manufacturing Technologies area:

a. Servicing products keeps them in good operating condition.

b. Materials can be classified as being natural (found in nature), synthetic (human made from natural resources), and a mix of both types.
c. Durable goods are designed to operate for a long period of time, while non-durable goods are designed to last for a short period of time.
d. Manufacturing systems can be classified into three types: customized production, batch production, and continuous production.
e. Manufacturing processes became more effective with the development of interchangeable parts.
f. Chemical technologies can be used to create or alter materials.
g. Marketing is an important aspect of manufacturing and should be used in development, advertising, and sales.

In the 2013-2014 school year, 5,203 students in Virginia took courses that were relevant to the Manufacturing Technologies content area (Virginia Department of Education, 2019d). There are ten secondary school Technology Education courses in the Manufacturing Technologies content area that have been matched to the SLT standards by the Virginia Department of Education: Engineering Analysis and Applications, Engineering Concepts and Processes, Engineering Design and Development, Engineering Drawing and Design, Engineering Explorations, Engineering Studies, Manufacturing Systems, Materials and Processes Technology, Modeling and Simulation Technology, and Production Systems. See appendix J for course descriptions.

Construction technologies.

There are many skills and processes involved in the design and building of structures, and there are numerous types of structures. Structures encompass many forms that include residential houses, commercial buildings, agricultural structures, and also projects such as roads, bridges, dams, parks, and temporary structures. These different types of structures require specialized professions, such as engineers, architects, contractors, electricians, and other skilled workers (Nam & Tatum, 1988). Almost all people are affected by construction in one form or another, and secondary students should be educated consumers by the time they graduate from high school.

The STL (2007) suggest that Technology Education students explore the different components of the construction field, with an emphasis on designing structures and making scale models. Students should understand that certain structures are part of a much larger infrastructure system, and standards and regulations are designed to make structures safe and lasting. Students should identify the various materials and systems that buildings comprise, and realize the impact of building materials and systems have on society and the environment. Students should also be aware of building maintenance, including how proper maintenance and repairs can extend the useful life of a project (ITEEA, 2007).

The STL recommend that secondary school (grades 9 – 12) Technology Education students learn the following standards in the Construction Technologies area:

a. Infrastructure is the basic framework that a society needs to function.
b. Construction relies on a variety of processes and procedures.
c. Structures must be designed to meet numerous requirements and codes.
d. Structures require maintenance and at some point may require alteration or renovation to improve the structure or alter its use.
e. Prefabricated materials or structures may be used in construction (ITEEA, 2007).

In the 2013-2014 school year, 9,104 students in Virginia took courses that were relevant to the Construction Technologies content area (Virginia Department of Education, 2019d). There are three secondary school Technology Education courses in the Construction Technologies content area that have been matched to the STL standards by the Virginia Department of Education: Architectural Drawing and Design, Construction Technology, and Civil Engineering and Architecture. See appendix J for course descriptions.

Summary

The theory of Assessing the Learning Strategies of Adults, or ATLAS, has been utilized in over 50 studies, using a variety of participants, both in and out of the United States (Conti & McNeil, 2012). Research has suggested that ATLAS learning strategy categories are consistent regardless of a person's nationality, culture, personality type, or demographic characteristics (Ausburn & Brown, 2006). Results of ATLAS testing have indicated that the general adult population has an ATLAS learning strategy distribution of 36.5% classified as *navigators*, 31.7% as *problem solvers*, and 31.8% as *engagers* (Conti & Kolody, 1999, 2004). Although the distribution in the general population has been found to be consistent, subgroups of the general population have been shown to differ. Most research with ATLAS theory has been along four themes: developing and improving the instrument, testing ATLAS with different groups, using ATLAS as a tool to improve instruction, and using ATLAS as part of an experiment (Conti & McNeil, 2012).

One group shown to significantly vary from the normal ATLAS distribution were learners that did not take the traditional pathway to their final level of education, which for the majority of students is from high school to university or college. Studies that focused on at-risk urban youth (Shaw, 2004), first generation community college students (Willyard, 2000), students that did not complete high school but returned to education (James, 2000), and students at a two-year technical school (Massey, 2001), suggested that these nontraditional learners tend to have more *engagers* than the general population. These studies also showed that these nontraditional students tended to prefer the same types of learning activities related to the *engager* learning strategy type.

Another alternative to the traditional high school to university route is Career and Technical Education (CTE), which is the general area of study that includes Technology Education. This similarity to nontraditional students led Ausburn and Brown (2006) to study secondary school CTE students to determine their ATLAS learning strategy distribution using a convenience sample of 621 CTE and Technology Education students in Oklahoma. The research showed that 45.4% of the population was *engager*, which is significantly higher than the general population (31.8%). They also conducted two follow-up studies of Career and Technical Students that found 47% *engagers* in the first study and 76% *engagers* in the second study, both of which are significantly higher than the general population.

Ausburn and Brown (2006) concluded that all three ATLAS learning strategy types exist in CTE and Technology Education classrooms, and that the *engager* learning strategy is significantly higher than the general population. Ausburn and Brown (2006) acknowledged that their findings needed to be “verified through replication and repetition” (p. 16), using different samples of CTE students in a variety of locations and program areas. They also suggested identifying the learning styles of both CTE students and teachers, and determining how they interact. To date there are no known studies that examine the ATLAS learning strategies of secondary school Technology Education teachers and their students.

CHAPTER THREE: METHODS

Overview

The purpose of this causal comparative study was to see if the proportions of *navigator, problem solver,* and *engager* learning types will be the same for secondary school Technology Education students and their teachers. Data was collected from secondary level Technology Education teachers and students in Virginia enrolled in classes during the spring semester of 2019. Chapter Three includes information about the study design, research question, null hypotheses, participants and setting, instrumentation, procedures, and analysis.

Design

A quantitative causal comparative study was used to compare the learning strategies of secondary school Technology Education teachers and their students using the ATLAS instrument to determine whether they have a *navigator, problem solver,* or *engager* preferred learning strategy. A quantitative causal comparative design was appropriate for this study in that the variables are categorical and cannot be manipulated, making ex post facto analysis the appropriate methodology (Gall, Gall, & Borg, 2010). The study attempted to determine if there was a statistically significant relationship between the proportions of Technology Education teachers with *navigator, problem solver,* or *engager* learning strategies and the proportions of Technology Education students with *navigator, problem solver*, or *engager* learning strategies. The study identified and compared the learning strategies of secondary school Technology Education teachers and their students taking classes in approved Technology Education courses as a whole, and also by the seven program areas identified in the ITEEA Standards for Technological Literacy. The ITEEA program areas are Medical Technologies, Agricultural and Related Biotechnologies, Energy and Power Technologies, Information and Communication

Technologies, Transportation Technologies, Manufacturing Technologies, and Construction Technologies (ITEEA, 2007). The study also identified four Virginia Department of Education technology education courses that did not directly relate to an ITEEA program area, so a nonaligned group was created.

The dependent variables were learning strategies: *navigator learning strategy*, *problem solver learning strategy*, and *engager learning strategy*. The dependent variables were determined using the online version of the ATLAS instrument, which was incorporated into a SurveyMonkey survey. The independent variables were the Technology Education teachers, and the Technology Education students. The Technology Education teachers were teaching a secondary level course (grades 8 through 12), including dual enrollment courses, in Virginia. The Technology Education students were taking a secondary level course (grades 8 through 12), and included dual enrollment students, in Virginia.

Research Question

RQ1: Will the proportions of *navigator, problem solver,* and *engager* learning types be the same for secondary school Technology Education students and their teachers in various Technology Education program areas?

Null Hypotheses

$H_0$1: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers for the overall ITEEA program areas.

$H_0$2: The proportions of *navigator, problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Medical Technologies program area.

$H_0$3: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Agriculture and Related Biotechnologies program area.

$H_0$4: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Energy and Power Technologies program area.

$H_0$5: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Information and Communication Technologies program area.

$H_0$6: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Transportation Technologies program area.

$H_0$7: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Manufacturing Technologies program area.

$H_0$8: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Construction Technologies program area.

$H_0$9: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Non-Aligned programs area.

Participants and Setting

The participants for the study were drawn from a convenience sample of secondary school Technology Education teachers and students located in Virginia, which included approximately 950 teachers and 123,000 students (Virginia Department of Education, 2019e). The study used licensed teachers and courses that were included on the approved list of courses for Technology Education in Virginia (Virginia Department of Education, 2019b). Only secondary school courses that were designed for 36 weeks of instruction were used, and no middle school courses that receive high school credit or adult education courses were included.

The researcher selected the teacher sample using contact information for current Technology Education teachers in Virginia provided by the Virginia Technology and Engineering Educator Association (VTEEA). The student sample was formed using the students that were taking a Virginia approved Technology Education course taught by an instructor in the teacher sample. Possible participants for the teacher sample were contacted by email.

The teacher group consisted of at least 100 public high school Technology Education teachers actively teaching in Virginia. The student group consisted of students in the classes of the Technology Education teachers with a goal of at least 50% participation. For this study, the minimum number of participants sampled for each of the two samples was 100, which exceeded the required minimum for a medium effect size with statistical power of .7 at the .05 alpha level (Gall, Gall, & Borg, 2010, p. 145). Additionally, no less than 20% of the contingency table cells had a value less than five participants (Green & Salkind, 2011).

Teachers

The Technology Education teacher sample consisted of 222 participants, 168 males and 54 females. Teaching experience was broken down into categories, with 50 having 1 to10 years, 78 having 11 to 20 years, 56 having 21 to 30 years, 32 having 31 to 40 years, and 6 having over 40 years. Participant age was broken down into categories, with 8 being 21 to 30 years old, 36 being 31 to 40 years old, 67 being 41 to 50 years old, 75 being 51 to 60 years old, and 35 being 61 or older. There were 4 teachers with an associate's degree, 79 with a bachelor's degree, 109 with a master's degree, 20 with an advanced studies degree, and 10 with a doctorate degree. There were 2 American Indian or Alaskan Native teachers, 1 Asian teacher, 24 Black or African-American teachers, 10 Hispanic or Latino teachers, 4 Native Hawaiian or other Pacific Islander teachers, 176 White teachers, and 5 teachers that classified themselves as Unspecified.

Students

The Technology Education student sample consisted of 998 males and 266 females, with 123 eighth graders, 485 freshmen, 357 sophomores, 127 juniors, and 174 seniors. There were 13 American Indian or Alaskan Native students, 58 Asian students, 113 Black or African-American students, 114 Hispanic or Latino students, 5 Native Hawaiian or other Pacific Islander students, 907 White students, and 59 students that classified themselves as Unspecified. There were 00 participants with an average age of 15.38 years old.

The student group consisted of 00 Medical Technologies students, 61 Agricultural and Related Biotechnologies students, 217 Energy and Power Technologies students, 187 Information and Communication Technologies students, 200 Transportation Technologies students, 288 Manufacturing Technologies students, 243 Construction Technologies students, and 77 students that were in the Non-Aligned group.

Table 1

Participants by ITEEA Program Area

Program Area	Students
Medical Technologies	00
Agricultural and Related Biotechnologies	61
Energy and Power Technologies	217
Information and Communication Technologies	187
Transportation Technologies	200
Manufacturing Technologies	288
Construction Technologies	243
Non-Aligned group	77
Total	1,273

Medical Technologies Group

None of the participants responded that they were currently taking a course directly related to the ITEEA Medical Technologies group

Agricultural and Related Biotechnologies Group

Students. The Agricultural and Related Biotechnologies student group had 46 males and 16 females with 16 eighth graders, 19 freshmen, 15 sophomores, 4 juniors, and 8 seniors. There were 00 American Indians or Alaskan Natives, 3 Asians, 6 Blacks or African-Americans, 6 Hispanics or Latinos, 00 Native Hawaiians or other Pacific Islanders, 44 Whites, and 3 that classified themselves as Unspecified. The average age was 15.58 years old.

Energy and Power Technologies Group

Students. The Energy and Power Technologies student group had 161 males and 46 females with 17 eighth graders, 89 freshmen, 63 sophomores, 14 juniors, and 24 seniors. There were 00 American Indians or Alaskan Natives, 10 Asians, 19 Blacks or African-Americans, 20

Hispanics or Latinos, 1 Native Hawaiians or other Pacific Islanders, 147 Whites, and 10 that classified themselves as Unspecified. The average age was 15.44 years old.

Information and Communication Technologies Group

Students. The Information and Communication Technologies student group had 152 males and 35 females with 18 eighth graders, 52 freshmen, 49 sophomores, 32 juniors, and 36 seniors. There were 4 American Indians or Alaskan Natives, 8 Asians, 19 Blacks or African-Americans, 13 Hispanics or Latinos, 1 Native Hawaiians or other Pacific Islanders, 133 Whites, and 9 that classified themselves as Unspecified. The average age was 15.74 years old.

Transportation Technologies Group

Students. The Transportation Technologies student group had 153 males and 47 females with 18 eighth graders, 89 freshmen, 60 sophomores, 11 juniors, and 24 seniors. There were 1 American Indians or Alaskan Natives, 10 Asians, 18 Blacks or African-Americans, 20 Hispanics or Latinos, 1 Native Hawaiians or other Pacific Islanders, 142 Whites, and 10 that classified themselves as Unspecified. The average age was 15.73 years old.

Manufacturing Technologies Group

Students. The Manufacturing Technologies student group had 232 males and 56 females with 20 eighth graders, 105 freshmen, 91 sophomores, 33 juniors, and 39 seniors. There were 5 American Indians or Alaskan Natives, 13 Asians, 21 Blacks or African-Americans, 25 Hispanics or Latinos, 1 Native Hawaiians or other Pacific Islanders, 211 Whites, and 12 that classified themselves as Unspecified. The average age was 15.16 years old.

Construction Technologies Group

Students. The Construction Technologies student group had 194 males and 49 females with 18 eighth graders, 91 freshmen, 67 sophomores, 30 juniors, and 37 seniors. There were 3 American Indians or Alaskan Natives, 10 Asians, 21 Blacks or African-Americans, 22 Hispanics or Latinos, 1 Native Hawaiians or other Pacific Islanders, 175 Whites, and 11 that classified themselves as Unspecified. The average age was 15.66 years old.

Non-Aligned Group

Students. The Non-Aligned student group had 60 males and 17 females with 16 eighth graders, 40 freshmen, 12 sophomores, 3 juniors, and 6 seniors. There were 0 American Indians or Alaskan Natives, 4 Asians, 9 Blacks or African-Americans, 8 Hispanics or Latinos, 0 Native Hawaiians or other Pacific Islanders, 55 Whites, and 4 that classified themselves as Unspecified. The average age was 14.23 years old.

Setting

The setting for the study varied according to the situation in each Technology Education classroom or lab, as all data was collected online. Teachers took the survey through SurveyMonkey, which included the ATLAS Learning Strategies instrument, through a link on the Technology Education teacher web site http://teteacher.weebly.com. Teacher data was entered whenever the teacher had access to the Internet. Students completed the survey and the instrument in the teacher's classroom, or in another lab with Internet connectivity, under the supervision of the teacher. The teacher gave directions for completing the survey/instrument and entering data into the survey by reading directions provided by the researcher, (See Appendix F for the directions). Students accessed the survey using the Technology Education student web site http://testudent.weebly.com. All data was collected between April 16, 2019, and May 16, 2019.

Instrumentation

The Assessing the Learning Strategies of Adults instrument, or ATLAS, was used for this study (See Appendix B for instrument). The purpose of using ATLAS was to determine the learning strategy of the teacher and student participants, which placed them into a category of having a *navigator, problem solver,* or *engager* learning strategy (Conti & Kolody, 2004). ATLAS is based on the theory that adults have developed a preferred strategy for approaching learning situations based on their previous real-world experiences (Ausburn & Brown, 2006).

ATLAS is a shortened and simplified version of the Self-Knowledge Inventory of Lifelong Learning Strategies (SKILLS) test, developed in the early 1990s by the Adult Learning Center at Montana State University, as a way for adult learners to measure how they prefer to use learning strategies to undertake learning in real-world situations (Fellenz & Conti, 1989). SKILLS consisted of twelve categories of real-world scenarios, with each scenario containing 15 items relating to metacognition, memory, metamotivation, resource management, and critical thinking (Fellenz & Conti, 1989). Two problems with SKILLS were that it was time consuming to take (approximately 20 minutes), and it was difficult to score (Conti, 2009).

The problems were an impetus for Conti and Kolody (1999) to develop the ATLAS model and corresponding instrument based on the SKILLS instrument. Cluster analysis was used to consolidate the five areas of the SKILLS test (metacognition, memory, metamotivation, resource management, and critical thinking) into the three categories of learning strategies in ATLAS: *navigator, problem solver,* and *engager* (Conti & Kolody, 1999). This resulted in the ATLAS instrument, which shares the SKILLS instrument's validity and reliability, but uses only a maximum of five responses and can be taken in three minutes or less (Ausburn & Brown, 2006).

ATLAS has been used in more than 50 studies, with the research focused on describing the groups of learners within ATLAS, using ATLAS to identify groups, and in experiments comparing groups of learners (Conti & McNeil, 2012). ATLAS has recently been used in several studies. Sanders and Conti (2012) and Ghost Bear (2012) used ATLAS to explore the individual differences in learners. Shaw, Conti, and Shaw (2013) investigated youth transitioning to adult learners. Conti and McNeil (2011) studied the relationship between learning strategies and personality type, and McIntosh (2012) used ATLAS to investigate the learning strategies of American Indians. Ausburn and Brown (2006) identified and compared the learning strategies of CTE students in several Midwestern states, including Technology Education students in the CTE population.

The construct validity of ATLAS was based on the SKILLS instrument that preceded it. The SKILLS inventory was based on Shirks's (1990) nine general categories of learning for real life situations, which require different types and levels of learning strategy. SKIILLS was originally validated using an extensive literature review on adult learning and also through the judgment of a group of adult education and educational psychology professors. Experts in adult education and educational psychology also critiqued the instrument individually and in small groups, and after some changes were made, the experts endorsed the SKILLS instrument (Conti & Fellenz, 1991).

SKILLS had been used in at least 16 studies in a variety of adult education fields before the development of ATLAS, resulting in 3070 cases that provided data that identified individuals' adult learning strategy (Conti, 2009). The ATLAS instrument used the 60 responses that were part of the SKILLS survey as variables in a cluster analysis. Using data from the 3070 cases, a cluster analysis revealed the three learning strategies used in the ATLAS model: *navigator, problem solver,* and *engager* (Conti, 2009). The ATLAS developers also conducted three separate discriminate analyses using five clusters, four clusters, and three clusters in SPSS, and the three-cluster design was found to form the most accurate set of clusters (Conti, 2009).

ATLAS is organized into a flow chart design with five items, and each item leads to two options (See Appendix B for flow chart). ATLAS does not provide an overall score to indicate the degree to which a person is a *navigator*, *problem solver*, or *engager*. Also, the instrument does not indicate the degree to which a person has characteristics that would put him or her in another learning strategy category. ATLAS does not recognize an overlap between a navigator, problem solver, or engager, so participants are only counted in one category. The most responses required to get a learning strategy result is three, and the instrument normally takes one to three minutes to complete (Conti, 2009). The instrument can be taken online at http://www.conti-creations.com/atlas.htm, and the instrument will place the subject into a learning strategy category immediately after completion of the survey. ATLAS can also be completed using a color-coded booklet that moves the user to questions on different colored pages depending on responses to the five items, and the resulting learning strategy category is revealed on the final item. The ATLAS instrument can be used individually or as part of a group taking it at the same time. The instrument may also be administered orally on an individual basis (Ausburn & Brown, 2006).

The reliability of ATLAS was established using a test – retest method using a group of 121 adult students. The time between testing was two weeks, with 110 (90.9%) indicating the same learning preference each time, resulting in a Pearson Correlation of .88 ($p < .001$) (Conti, 2009). Other studies testing the ATLAS model have determined similar results, with Ghost Bear (2001) finding .87 ($p < .001$), and Ausburn and Brown (2006) finding .90 ($p < .001$).

As the copyright holder, Dr. Gary Conti provided permission to use the ATLAS instrument for use in this study in any way that the researcher felt appropriate. Dr. Conti requested through email that a copy of the dissertation abstract be sent to him at the conclusion of the study, but did not charge for the use of ATLAS and did not put any restrictions on its use. See appendix A for permission to use the instrument.

Procedures

The setting for the study varied according to the situation in each Technology Education classroom or lab, as all data was collected online. Teachers took the SurveyMonkey survey, which included the ATLAS Learning Strategies instrument, through a link on the Technology Education teacher web site, http://teteacher.weebly.com. Teacher data was entered whenever the teacher had access to the Internet. Students completed the survey and the instrument in the teacher's classroom, or in another lab with Internet connectivity, under the supervision of the teacher. The teacher gave directions for completing the survey/instrument and entering data into the survey by reading directions provided by the researcher (See Appendix G for the directions). Students accessed the survey using the Technology Education student web site http://testudent.weebly.com. All data was collected between April 16, 2019, and May 16, 2019.

IRB approval was obtained to administer the ATLAS instrument to Technology Education teachers and students in the state of Virginia. IRB also approved the use of SurveyMonkey to collect the learning strategy result, general demographic information, and the title of the participant's Technology Education course. It was also determined that the students participating in the study needed to provide their assent; however, parental permission was not required. See appendix I for IRB approval.

Teacher participants were elicited via email using the contact list available on the Virginia Technology and Engineering Educators Association (VTEEA) web site, with the permission of the VTEEA administrators. See Appendix C for permission to use the VTEEA contact data. Any teachers that did not teach secondary Technology Education were excluded from the study. The email included a brief description of the study and directions for the teacher to take the survey. The email also included directions for students to participate in the survey, and a script for administering the survey was attached to the email (See Appendix F). Each teacher received the same email, and the transcript is included in Appendix G. The teacher determined the date and time to take the ATLAS survey, and the teacher read the script (attached to the email) to the class, directing the students how to complete the study (See Appendix F for instructions). Those students that agreed to participate were provided the link to the student survey, http://testudent.weebly.com. The student survey included an assent form and links to exit the survey (See Appendix E for the Student Survey). The teacher participants followed the same instructions as the students; however, they used the http://teteacher.weebly.com link to access the teacher survey and completed the survey as time allowed. The teacher survey included a consent form and links to exit the survey, and it redirected the participant to a web site, http://technologyeducationstudy.weebly.com, which allowed the participant to register for a drawing to win one of three $50.00 Lowes gift cards (See Appendix D for the teacher survey). After two weeks an email was sent to the teachers reminding them that they could still participate in the study, along with the original directions for participation (See Appendix H). Data from

Survey Monkey was downloaded into the Statistical Package for Social Sciences (SPSS) and analyzed using the Pearson chi square test for independence.

Analysis

The Pearson chi square test for independence was used to compare the learning styles (*navigator, problem solver*, *engager*) of secondary school Technology Education teachers and their students, and to further explore if there is a significant statistical relationship between the learning strategies of teachers and students by ITEEA program area (Green & Salkind, 2011). The Chi Square Test for Independence was chosen because the data are categorical and in the form of frequency counts (Gall, Gall, & Borg, 2010). A two-way contingency table analysis was used to explore the *homogeneity of proportions* in the study (Green & Salkind, 2011).

A two-way contingency table analysis was conducted to evaluate if there was a statistically significant relationship between the proportions of Technology Education teachers with *navigator*, *problem solver,* or *engager* learning strategies and the proportions of Technology Education students with *navigator*, *problem solver,* or *engager* learning strategies (Green & Salkind, 2011). The dependent variables *navigator learning strategy*, *problem solver learning strategy*, and *engager learning strategy*, were used as column variables in the tables. The independent variables Technology Education teachers and Technology Education students were used for the row variables.

The assumption that the observations are independent of each other was addressed by having separate samples. The two independent variable groups, Technology Education teacher, and Technology Education student, are not related, and each group has a different survey link and survey. The assumption that the sample size is large enough to produce a test statistic that is approximately distributed as a Chi-Square was addressed by having a sufficient number of participants to ensure that each cell had a frequency of greater than 5. In contingency tables that have cells with a frequency of less than 5, there may be a problem with validity of the results (Green & Salkind, 2011).

SPSS reported a Pearson chi-square test statistic in the form of a *p* value, which was used with a significance of .05 to determine whether or not to reject the null hypothesis (Green & Salkind, 2011). Phi and Cramér's V were used to assess the strength of the relationship between the row variables and the column variables. Follow-up comparisons were conducted to evaluate significant pairwise relationships between the variables. The Holm’s sequential Bonferroni method was used to control for Type 1 error at the .05 level (Green & Salkind, 2011), so the alpha level was set at .006. A clustered bar chart was used to show the frequency of *navigator*, *problem solving*, and *engager* learning strategies for Technology Education teachers and Technology Education students.

CHAPTER FOUR: RESULTS

Overview

This chapter will discuss descriptive statistics and the results of two-way contingency table analysis. The results for the null hypotheses will be presented for Technology Education teachers and students as a whole using ITEEA program areas, as well as a group of students that did not fit into an ITEEA program area.

Research Question

The research question for this study was as follows:

RQ1: Will the proportions of *navigator*, *problem solver*, and *engager* learning types be the same for secondary school Technology Education students and their teachers in various Technology Education program areas?

Descriptive Statistics

This study sought to determine if the proportions of *navigator*, *problem solver*, and *engager* learning types are the same for secondary school Technology Education students and their teachers in eight Technology Education program areas. The data suggest that secondary Technology Education teachers and students have different preferred learning strategies, as a whole, and across the ITEEA program groups. Table 2 provides a summary of the descriptive statistics reported as percents.

Table 2

Student Learning Strategies in Percents

Program Area	Engager	Navigator	Problem Solver
All participants	46%	25%	29%
Medical Technologies	No data	No data	No data
Agriculture & Biotech.	38%	31%	31%
Energy and Power	43%	25%	32%
Information & Comm.	46%	27%	27%
Transportation	46%	26%	28%
Manufacturing	47%	26%	27%
Construction	46%	27%	26%
Non-Aligned	38%	31%	31%

Results

A two-way contingency table analysis was conducted at the 95% confidence level to evaluate whether the proportions of *navigator, problem solver,* and *engager* learning types were the same for secondary school Technology Education students and their teachers. A Bonferroni method was used to control for Type 1 error at the .05 level (Green & Salkind, 2011), so the alpha level was set at .006. The dependent variables were *navigator, problem solver,* and *engager* learning strategies. The independent variable were technology education teachers, and technology education students. The following nine nulls hypotheses were examined:

$H_0$1: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers for the overall ITEEA program areas.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 613) = 49.28$, $p < 0.001$. The null hypothesis was rejected. Figure 1 compares the percentage of teachers and students that have been identified as having a *navigator, problem solver,* or *engager* learning strategy. Frequencies for null $H_0$1are in Table 3.

Table 3

Frequency Table – All Teachers and Students

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	179	97	115	391
Totals	218	178	217	613

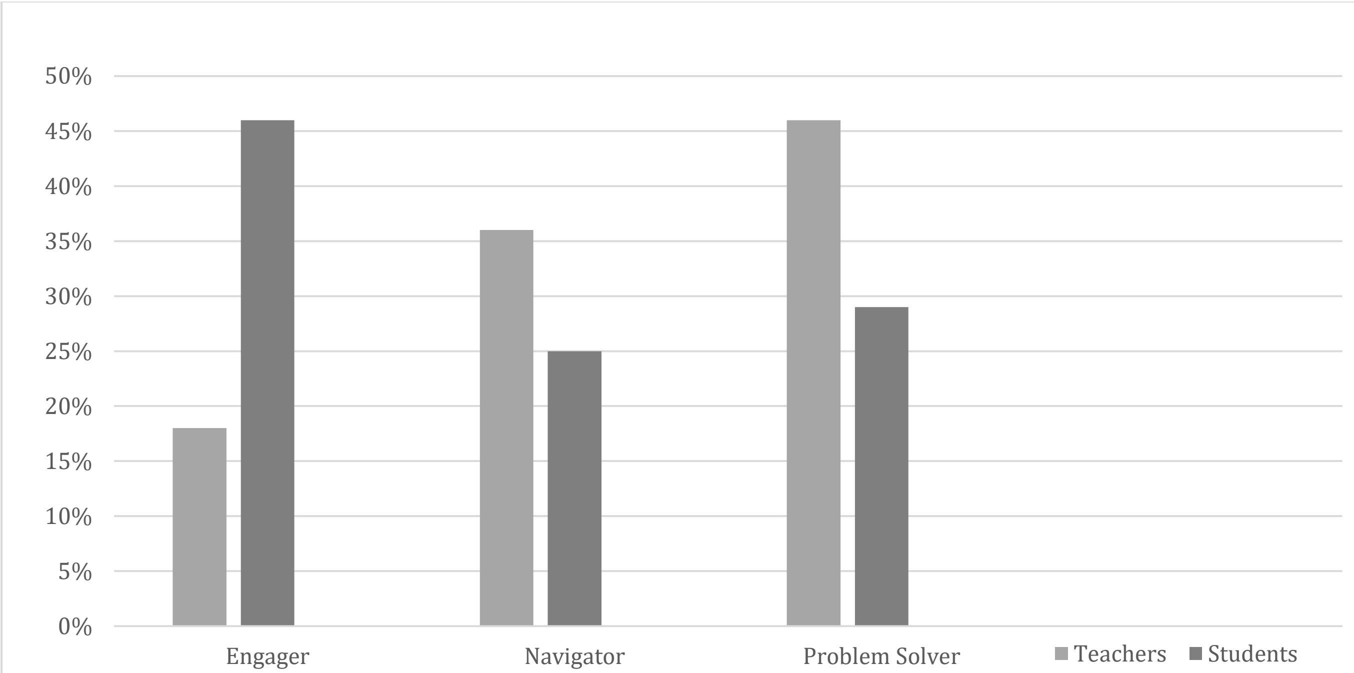

Figure 1. All teachers and students – comparison by learning strategy.

$H_0$2: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Medical Technologies program area.

No data was collected related to the Medical Technologies program area.

$H_0$3: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Agriculture and Related Biotechnologies program area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 238) = 11.69$, $p < 0.003$. The null hypothesis was rejected. Figure 2 compares the percentage of teachers and students that have been identified as having a *navigator*, *problem solver*, or *engager* learning strategy. Frequencies for null $H_0$3 are in Table 4.

Table 4

Frequency Table – Agriculture and Related Biotechnologies

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	23	19	19	61
Totals	62	100	121	283

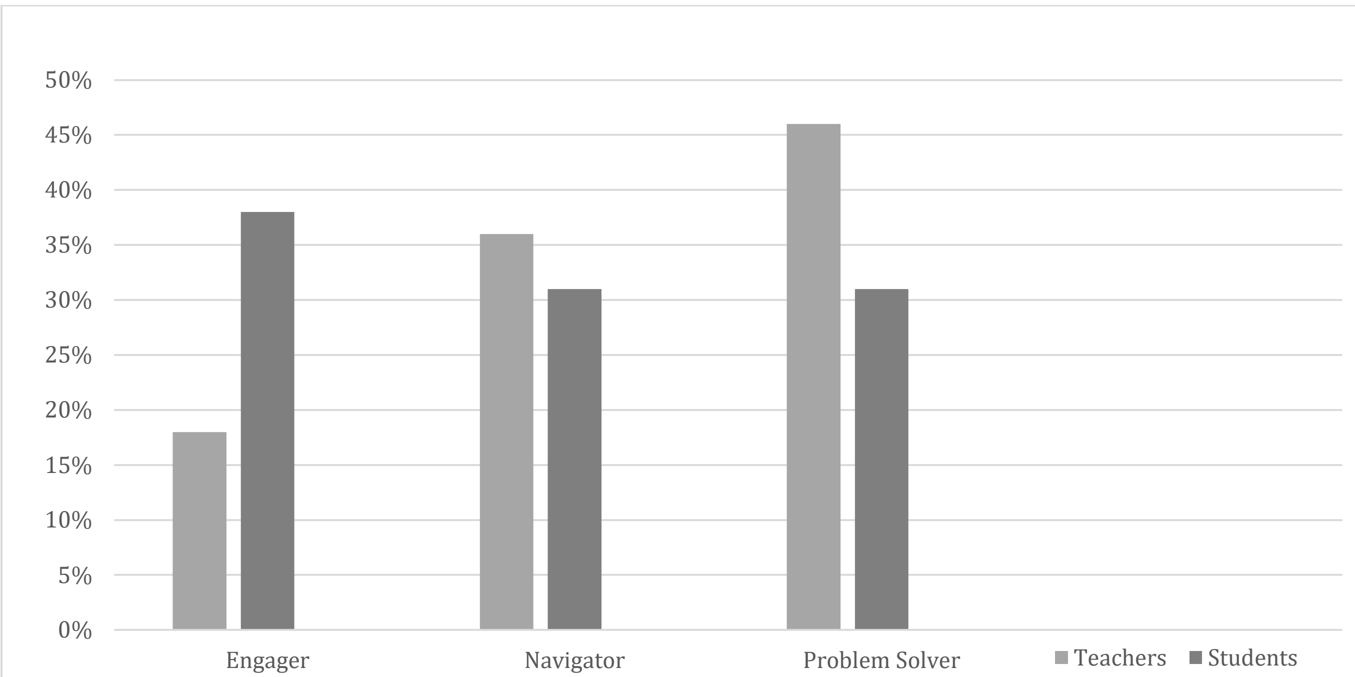

Figure 2. Agriculture and Related Biotechnologies – comparison by learning strategy.

$H_0$4: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Energy and Power Technologies program area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 439) = 49.28$, $p < 0.001$. The null hypothesis was rejected. Figure 3 compares the percentage of teachers and students that have been identified as having a *navigator*, *problem solver*, or *engager* learning strategy. Frequencies for null $H_0$4are in Table 5.

Table 5

Frequency Table – Energy and Power

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	98	52	67	217
Totals	137	133	169	439

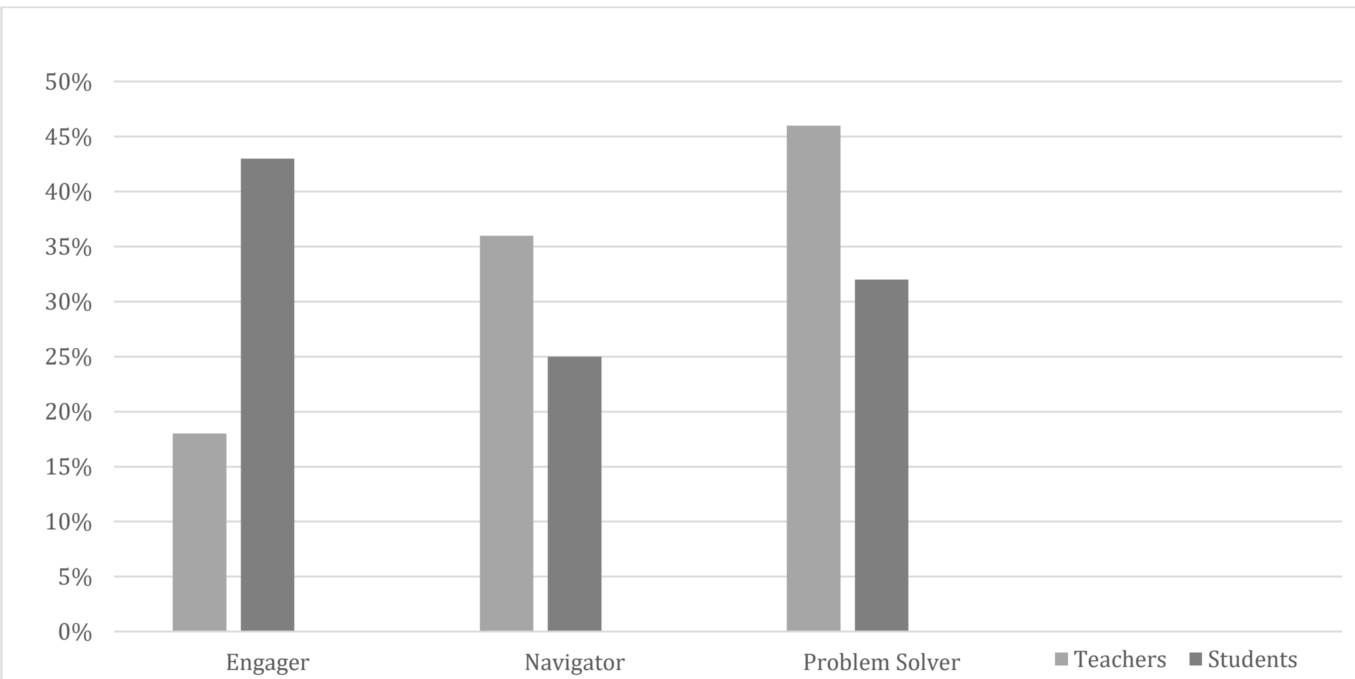

Figure 3. Energy and Power – comparison by learning strategy.

$H_0$5: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Information and Communication Technologies program area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 409) = 49.28$, $p < 0.001$. The null hypothesis was rejected. Figure 4 compares the percentage of teachers and students that have been identified as having a *navigator*, *problem solver*, or *engager* learning strategy. Descriptive statistics for null H_05 are in Table 6.

Table 6

Frequency Table – Information and Communication

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	86	50	51	187
Totals	125	131	153	409

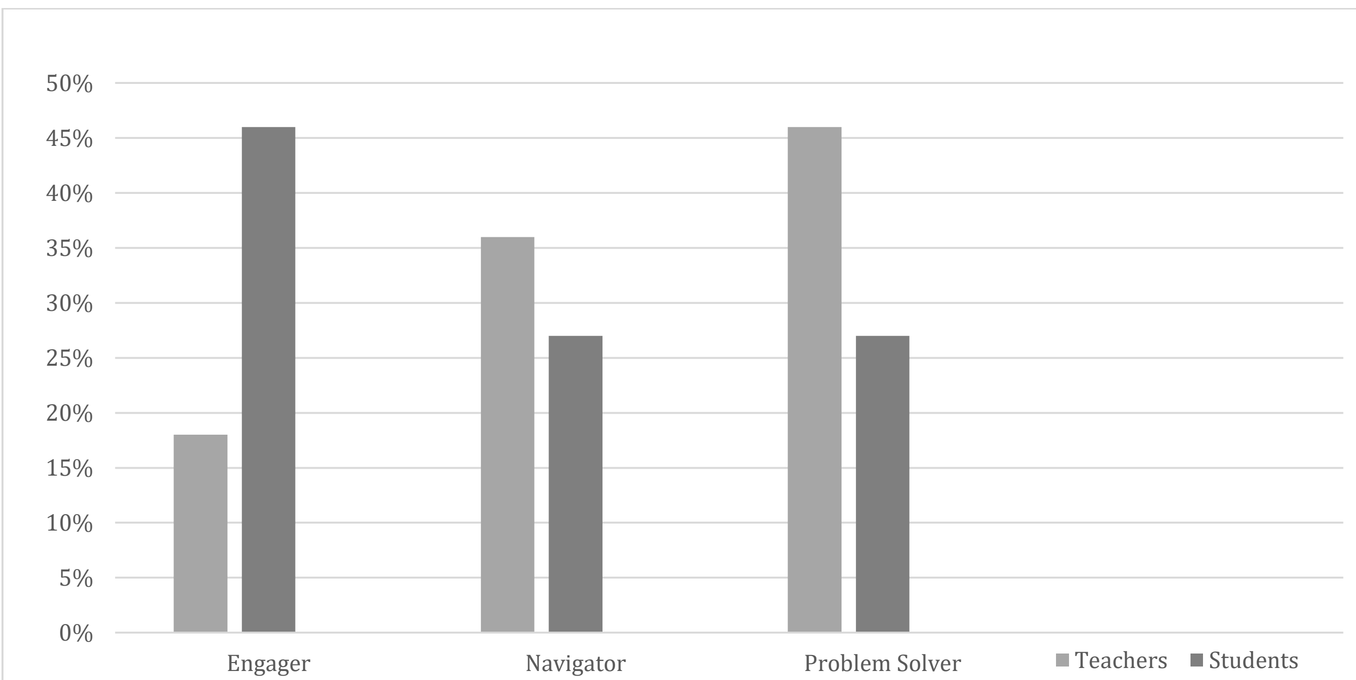

Figure 4. Information and Communication – comparison by learning strategy.

$H_0$6: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Transportation Technologies program area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 422) = 39.96$, $p < 0.001$. The null hypothesis was rejected. Figure 5 compares the percentage of teachers and students that have been identified as having a *navigator, problem solver,* or *engager* learning strategy. Frequencies for null $H_0$6 are in Table 7.

Table 7

Frequency Table – Transportation

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	92	51	57	200
Totals	131	132	159	422

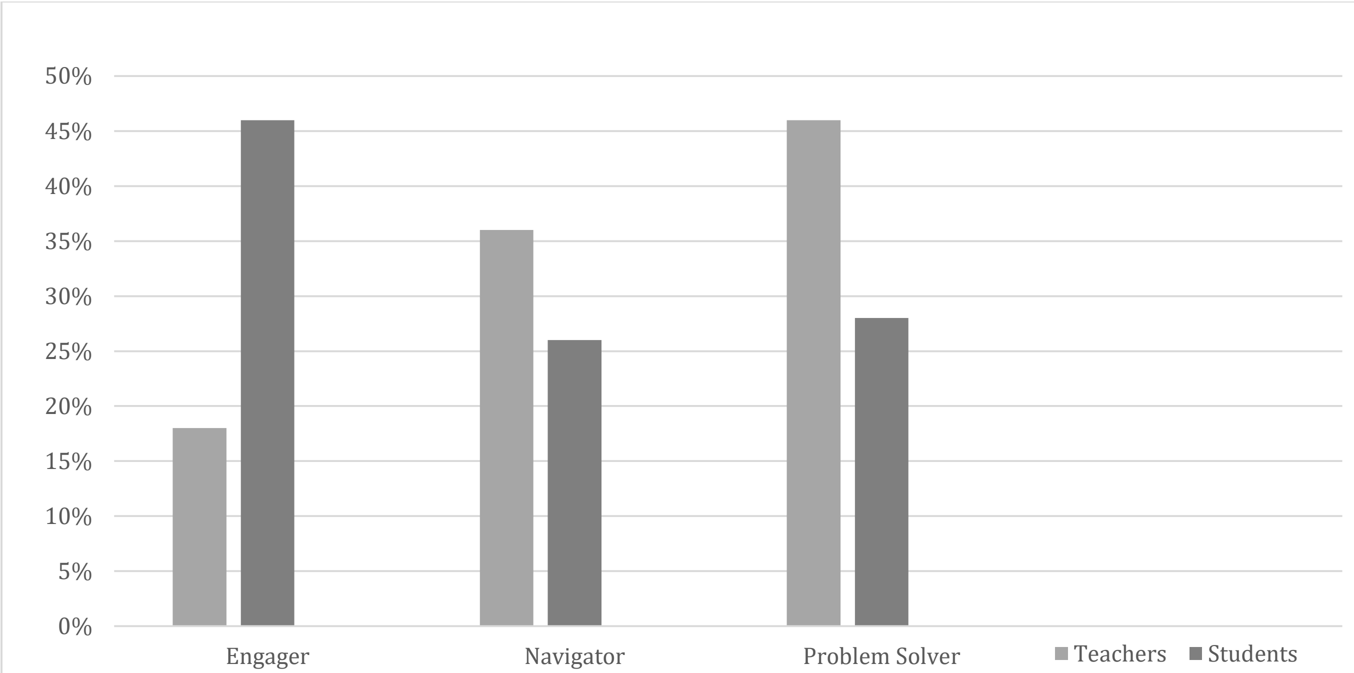

Figure 5. Transportation – comparison by learning strategy.

$H_0$7: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Manufacturing Technologies program area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 510) = 49.57$, $p < 0.001$. The null hypothesis was rejected. Figure 6 compares the percentage of teachers and students that have been identified as having a *navigator, problem solver*, or *engager* learning strategy. Frequencies for null $H_0$7 are in Table 8.

Table 8

Frequency Table – Manufacturing

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	136	74	78	288
Totals	175	155	180	510

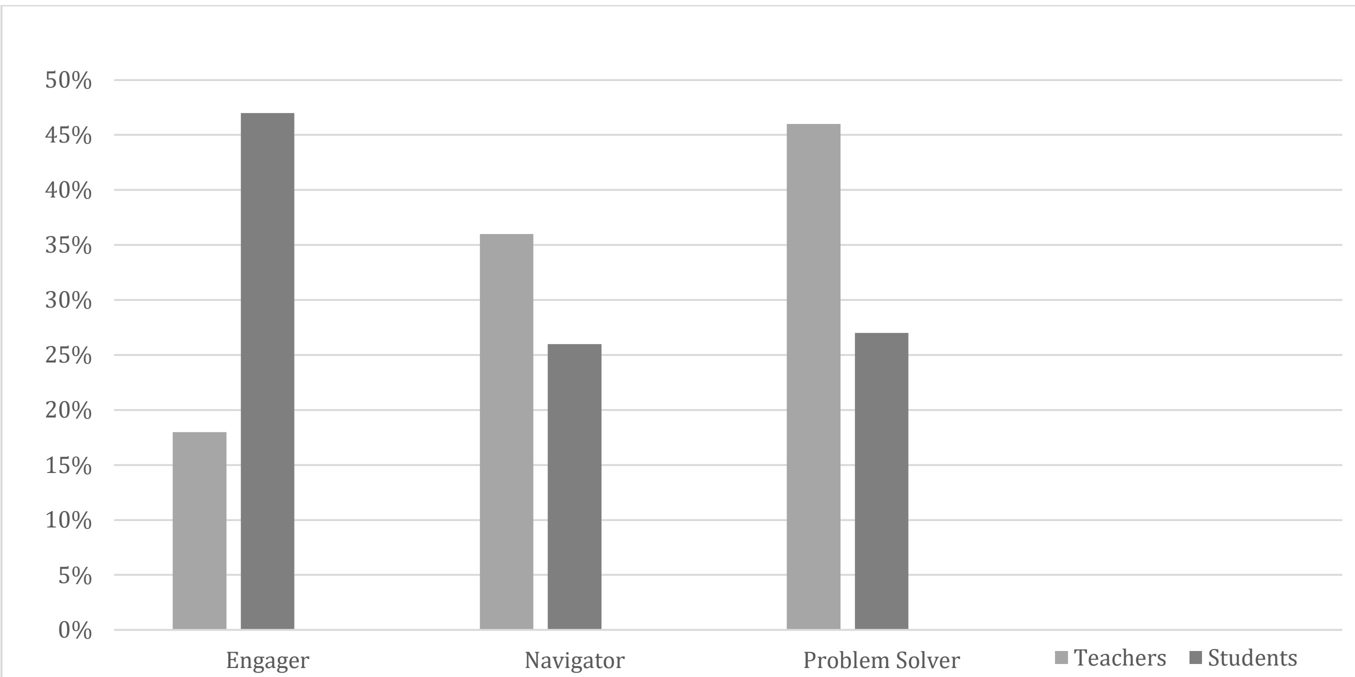

Figure 6. Manufacturing – comparison by learning strategy.

H₀8: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Construction Technologies program area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 465) = 44.46$, $p < 0.001$. The null hypothesis was rejected. Figure 7 compares the percentage of teachers and students that have been identified as having a *navigator*, *problem solver*, or *engager* learning strategy. Frequencies for null H_08 are in Table 9.

Table 9

Frequency Table – Construction

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	112	67	64	243
Totals	151	148	166	465

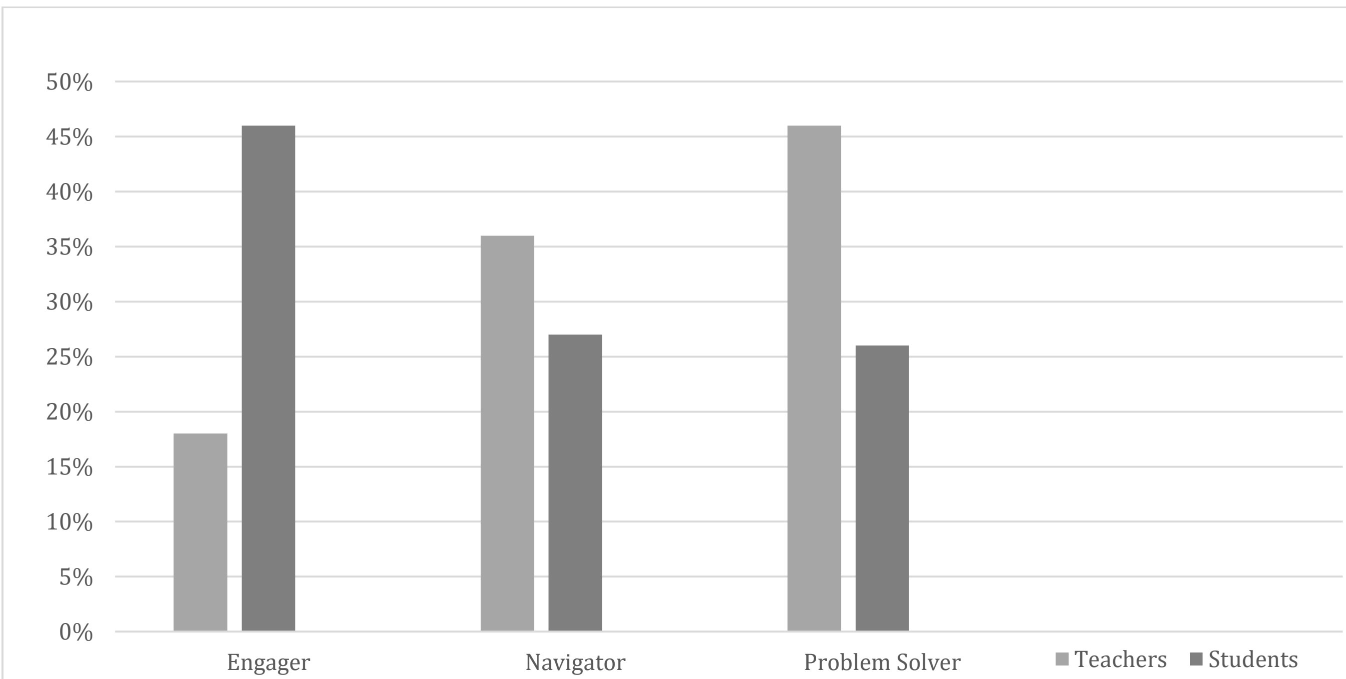

Figure 7. Construction – comparison by learning strategy.

$H_0$9: The proportions of *navigator*, *problem solver*, and *engager* learning types will not be the same for secondary school Technology Education students and their teachers in the Non-Aligned programs area.

The learning strategies of teachers and students were found to be significantly different, Pearson $\chi^2(2, N = 299) = 26.13$. The null hypothesis was rejected. Figure 8 compares the percentage of teachers and students that have been identified as having a *navigator*, *problem solver*, or *engager* learning strategy. Frequencies for null $H_0 9$ are in Table 10.

Table 10

Frequency Table – Non-Aligned

	Engager	Navigator	Problem Solver	Row Totals
Teachers	39	81	102	222
Students	36	20	21	77
Totals	75	101	123	299

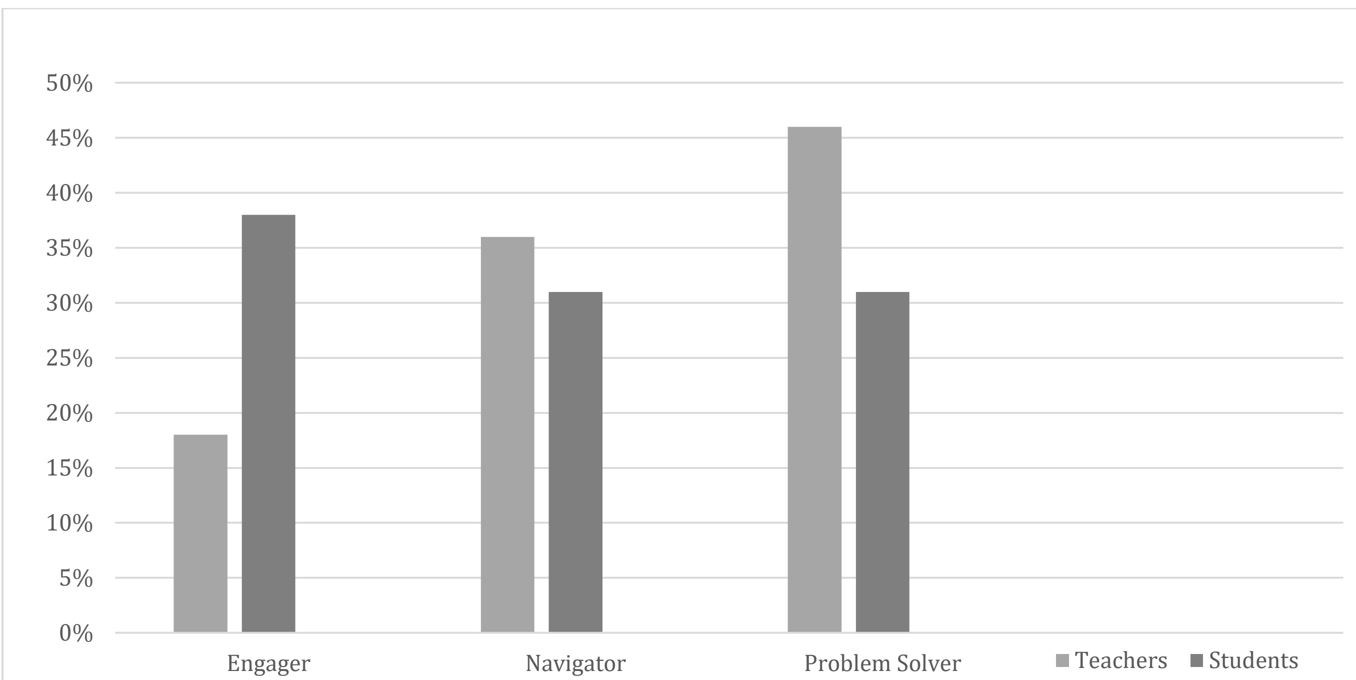

Figure 8. Non-Aligned – comparison by learning strategy.

Summary

This study sought to determine if the proportions of *navigator, problem solver,* and *engager* learning types are the same for secondary school Technology Education students and their teachers in eight Technology Education program areas. The nine null hypotheses were based on program area groupings and all of the null hypotheses were rejected. The data suggest that secondary Technology Education teachers and students have different preferred learning strategies, as a whole, and across the ITEEA program groups. See Table 11 for a summary of the results.

Table 11

Summary of the Results

Program Area	Statistics	Null Rejected
All participants	$\chi^2(2, N = 613) = 49.28, p < 0.001$	Yes
Medical Technologies	No data	-----
Agriculture & Biotech.	$\chi^2(2, N = 283) = 11.69, p < 0.003$	Yes
Energy and Power	$\chi^2(2, N = 439) = 38.93, p < 0.001$	Yes
Information & Comm.	$\chi^2(2, N = 409) = 39.30, p < 0.001$	Yes
Transportation	$\chi^2(2, N = 422) = 39.96, p < 0.001$	Yes
Manufacturing	$\chi^2(2, N = 510) = 49.57, p < 0.001$	Yes
Construction	$\chi^2(2, N = 299) = 26.13, p < 0.001$	Yes
Non-Aligned	$\chi^2(2, N = 299) = 26.13, p < 0.001$	Yes

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this causal comparative study was to see if the proportions of *navigator, problem solver,* and *engager* learning types would be the same for secondary school Technology Education students and their teachers. The learning strategies of high school and middle school Technology Education teachers were compared to all Technology education students, to students in nine ITEEA program areas, and to the general public. The learning strategies of high school and middle school Technology Education students were compared to the general population, and to students in other ITEEA program areas. Chapter Five will provide a discussion of research to date and address the research questions. Implications for practice, implications for research, recommendations, limitations, and a summary are included.

Discussion

Ausburn and Brown (2006) researched the relationship between learning strategies and the instructional preferences of CTE students, including Technology Education students, and found the students in their study had a predominant learning strategy categorized as "*engager,*" which varied from the general population. Ausburn and Brown (2006) recommended that the study of learning strategies be expanded to include more CTE instructional areas. As a branch of CTE, Technology Education qualified as an area of study, and the authors stated that more research was needed in identifying the learning strategies of teachers as well as students.

Students

Research has established ATLAS norms for the general population to be *engagers* 31.8%, *navigators* 36.5%, and *problem solvers* 31.7% (Conti & Kolody, 2004). Percent among secondary school Technology Education students when compared to the general norms tend to be *Engagers*. An engager is the type of student that loves to learn and brings a passion to learning. They like to be engaged with the classroom assignment, the teacher, the subject matter, and the environment around them (Conti, 2009). Engagers like to approach a problem or learning task using the affective domain in that they like to internally reflect as to whether the assignment will be enjoyable and/or worth the effort to complete (Ghost Bear, 2001). Emotion is an important aspect of engagers. They express their emotion in their ability to build relationships with others, and also through the use of emotional words such as "love and fun" (Conti, 2009, p. 894). Engagers find learning appealing when they relate to a learning task, and they tend to fully immerse themselves in the assignment, taking joy in mastery of a new concept (Conti, 2009). See Table 12 for Student Learning Strategies in Percents.

Table 12

Student Learning Strategies in Percents

Program Area	Engager	Navigator	Problem Solver
All participants	46%	25%	29%
Medical Technologies	No data	No data	No data
Agriculture & Biotech.	38%	31%	31%
Energy and Power	43%	25%	32%
Information & Comm.	46%	27%	27%
Transportation	46%	26%	28%
Manufacturing	47%	26%	27%
Construction	46%	27%	26%
Non-Aligned	38%	31%	31%

Teachers

As stated previously, research has established ATLAS norms for the general population to be *engagers* 31.8%, *navigators* 36.5%, and *problem solvers* 31.7% (Conti & Kolody, 2004). Percent among secondary school Technology Education teachers when compared to the general norms tend to be *problem solvers*. Problem solvers tend to look for external learning strategies and use the resources to develop alternative learning solutions (Conti, 2009). Problem solvers can be indecisive, with much of their learning time being devoted to developing new approaches to learning or searching for new learning solutions. One of the ways they make decisions is through telling stories. Through telling stories, problem solvers lay out their rationale for the learning strategy they ultimately choose (Ghost Bear, 2008). Problem solvers like to procrastinate because it gives them more time to come up with solutions (Conti, 2009). They also do not like to have the learning process interrupted because once they are distracted it is hard to pick back up from where they were (Conti, 2009). Problem solvers tend to be, “curious, inventive, and intuitive” (Conti, 2009, p. 894). See Table 13 for Teacher Learning Strategies in Percents.

Table 13

Teacher Learning Strategies in Percents

Program Area	Engager	Navigator	Problem Solver
All participants	18%	36%	46%
Medical Technologies	No data	No data	No data
Agriculture & Biotech.	17%	38%	45%
Energy and Power	17%	36%	47%
Information & Comm.	14%	37%	49%
Transportation	22%	34%	44%
Manufacturing	19%	35%	46%
Construction	19%	35%	46%
Non-Aligned	21%	36%	43%

Students vs. Teachers

When comparing Technology Education teachers and students as a whole, the null hypotheses were rejected across all programs. These data indicate that Technology Education teachers and students are significantly different in regards to their preferred ATLAS learning strategy. All the nulls where significantly different in this study. It was seen that technology students tend to be *engagers* whereas technology teachers tended to be *problem solvers*.

This study found that Technology Education teachers have significantly different ATLAS preferred learning strategies than their students. Technology Education teachers had a significantly higher proportion of *problem solvers* than both the general population and the Technology Education students. This is in keeping with data from an earlier study by McCaskey (2009) suggested that CTE teachers have a higher proportion of *problem solvers*. The teachers also had significantly lower proportions of *engagers* than the students and the general population, while the *engager* group was highest proportionally among students. The proportion of teacher *engagers* confirms earlier research by McCaskey (2009).

The differences between students (*engagers*) and teachers (*problem solvers*) learning strategies may have an impact in the classroom. One possible advantage of having different learning strategies is that students may be challenged to use learning strategies that they do not normally utilize when they confront a learning task. Since learning strategies are techniques for learning, and not internalized cognitive traits, they can be taught to students (Conti & McNeil, 2012). Problem solvers tend to develop new approaches to learning and develop alternative learning solutions, so students (*engagers*) could be provided with different ways to master content, increasing motivation to learn (Conti, 2009). The disadvantage is that teachers tend to teach learning material in a way that fits their preferred learning strategy (Conti & McNeil, 2012). If all of the course content is taught using the learning strategies of teachers (*problem solvers*) then students have limited opportunities to demonstrate mastery using their preferred learning strategies. When students are allowed to demonstrate knowledge of a concept or objective using assessments that match their learning preference, mastery of the material is enhanced (Lehman, 2011).

Implications for Practice

This study and prior research has suggested that Technology Education students have a strong tendency to have an *engager* learning strategy, with a fewer than average number of *navigators*. This information may be helpful with instructional planning in that instructional techniques geared toward the *engager* learning type may positively affect more students. However, Technology Education teachers can expect to find a mix of all three ATLAS learning strategy types in their classroom, so understanding the individual needs of all students is important when developing curriculum.

It is important that students are self-aware of their learning strategy, as research has suggested that students who are aware of their preferred learning strategy have higher achievement than those that are not aware of their preferred learning strategy (Schleicher, 2011). The ATLAS survey takes less than three minutes to complete and provides a description of the identified learning strategy preference at the end of the instrument. Multiple studies have shown that over 90% of the students taking the ATLAS instrument agreed that ATLAS correctly identified their learning strategy (Ausburn & Brown, 2005; Conti & Kolody, 2004; Ghost Bear, 2001). Metacognition is important in that it encourages students to understand and choose the learning strategies that benefit them the most, and it helps the student to plan or modify learning tasks so that the task is relevant to them. Metacognition allows students to take charge of their own learning, which enhances academic performance and increases the relevancy of the instructional material (Hartman, 2001).

Technology Education teachers need to be aware of their own learning strategy as well as the learning strategies of their students. This study suggests that Technology Education teachers have a very significant difference in their preferred learning strategies, and especially in the *engager* and *problem solver* strategies. Teachers need to be cognizant that a one size fits all approach is not always the most effective teaching strategy and that a teacher's preference for learning in a certain way does not mean that methodology is appropriate for all students. ATLAS is an easy way to determine the preferred learning strategies of students, and it assists with differentiation. After teachers determine the individual learning strategies of their students, they can group students with the same strategy together and/or provide student choice for demonstrating mastery. When teachers are aware of the preferred learning strategies of students, they can differentiate instruction for students, and/or provide alternatives for evaluating mastery that meet several different learning strategy preferences (Duhaney, 2012).

Implications for Research

This study confirmed some of the conclusions from other ATLAS learning strategies research. In previous studies of CTE students, three independent populations took the ATLAS instrument, and it was found that CTE students have a significantly higher proportion of *engagers* than the general population. This study with Technology Education students, a program within the CTE area, also found that students have a significantly higher proportion of *engagers* than the general population. Finding that three groups of CTE students in Oklahoma have essentially the same learning strategy proportions as CTE/Technology Education students in Virginia is a result that could inspire many ATLAS studies. This correlation should help future researchers to confirm the existing ATLAS data and study other subgroups in CTE.

Recommendations

This study confirmed previous research using ALTAS learning strategy types with CTE students, but this is the first known study to compare the learning strategies of Technology Education students and teachers exclusively. This research design should be replicated with groups of Technology Education teachers and students from a variety of locations and compared across ITEEA program areas. Research is very limited on the learning strategies of CTE and Technology Education instructors as well, so identifying the distribution of ATLAS learning strategies in a variety of locations would add to the existing knowledge of learning strategies and verify previous results.

Limitations

This study has potential limitations. The sample size was adequate for Chi-Square analysis, but it was limited to Technology Education teachers and students in the Commonwealth of Virginia. Each state has its own Technology Education courses and requirements for curriculum, so even a course with the same name in another state may have different content. Using International Technology and Engineering Educators Association (ITEEA) program areas to group students was used to minimize this limitation.

Access to Technology Education teachers and students was also limited. The list of email addresses for Technology Education teachers was almost two years old, and not all schools list email addresses for employees. This caused approximately 10% of the available emails to be undeliverable. Access to students was limited because the IRB required written superintendent and principal permission, and response was about 50%. Student access was also limited because the teacher had to agree to make the study part of his or her class lesson. The student sample of 1,273 was sufficient but came short of the expected 2000.

The data were all self-reported via online survey, so there was no way to verify the data. Responses were limited by the survey design to pre-populated responses, limiting irrelevant responses not directly related to the survey. This is the only known ATLAS research to involve Technology Education teachers and Technology Education students and to use ITEEA program areas for comparison, so research is very limited in this area.

Summary

This study is an extension of the ATLAS learning strategies research originally developed by Dr. Gary Conti and his staff at Oklahoma State University in the 1990’s. A colleague of Dr. Conti, Dr. Lynna Ausburn, has performed extensive research using the ATLAS model with Career and Technical Education students, and her research provided the problem for this study: There has not been adequate research identifying and comparing the learning strategies of Technology Education teachers and their students using the ATLAS model. As a branch of Career and Technical Education, Technology Education was an appropriate way to extend the existing knowledge of CTE students' learning strategies.

There is no known research specifically identifying the learning strategies of Technology Education teachers, and the research on Technology Education students is limited. This study determined that Technology Education students have the same general proportions of *engager*, *navigator*, and *problem solver* learning strategies as previous research with CTE students. The study also found that Technology Educations students have a significantly higher proportion of *engagers*, which also aligns with prior research. In addition to confirming the alignment of learning strategies between Technology Education students and CTE students, this study suggests that Technology Education teachers have a significantly higher proportion of *problem solvers* than both their students and the general population.

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APPENDICES

Appendix A:

Permission to Use ATLAS

Oklahoma State University

April 29, 2014

To: Mike Craft
From: Gary J. Conti, Professor of Adult Education (Retired)
Re: Permission to use ATLAS

It is always exciting to hear of new ways that researchers have found to use Assessing The Learning Strategies of AdultS (ATLAS). Feel free to use ATLAS in the ways you believe are most appropriate. You can access ATLAS on my website at

http://www.conti-creations.com/atlas.htm

Since I am the copyright holder for ATLAS, you may consider this letter as your formal permission to use ATLAS in any way you need for your research. Let me know what you find. Good luck.

Appendix B

ATLAS Item Flow Chart

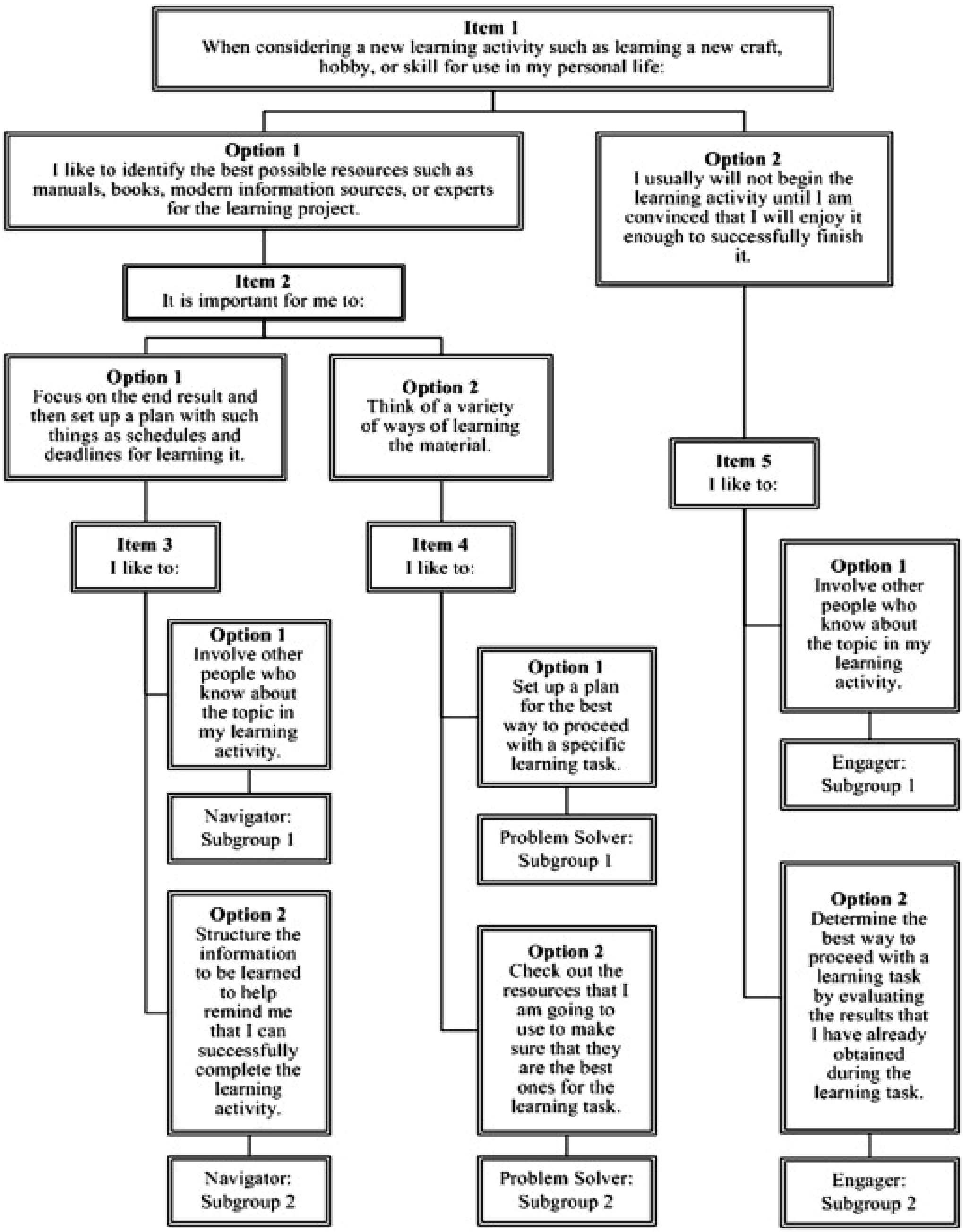

Fig. 1.

Flow-chart of items in ATLAS.

Figure options

Appendix C

Permission to Use the VTEEA Contact List

VTEEA contacts. Inbox x

Mike Craft <mike.craft@bvcps.net> Mar 18
to George

George,

I see that your name comes up as the VTEEA web site coordinator. I am working on my dissertation, and would like to use the contact information on the VTEEA site to contact some Technology Education teachers about participating in a study. Is it alright to use the email addresses listed in the contact page of the VTEEA website to contact some teachers about my study?
I hope you are doing well!

...

Willcox, George (DOE) <george.willcox@doe.virginia.gov> Mar 19
to me

Hi Mike:

Congratulations on your pursuit of an advanced degree! Yes, do not hesitate to use the contact information on the VTEEA Web site.

Wishing you much success!
George

From: Mike Craft [mailto:mike.craft@bvcps.net]
Sent: Wednesday, March 18, 2015 4:03 PM
To: Willcox, George (DOE)
Subject: VTEEA contacts.

...

The information conveyed in this communication is intended for the use of the original addressee(s), and may be legally privileged, confidential, and/or exempt from disclosure under applicable law. If this communication was not addressed or copied to you, then you have received it in error and are strictly prohibited from reading, copying, distributing, disseminating, or transmitting any of the information it conveys. If you received this communication in error, please destroy all electronic, paper, and other copies, and notify the sender of the error immediately. Accidental transmission of this communication is not intended to waive any privilege or confidentiality protected under Virginia's Freedom of Information Act.

Buena Vista City Public Schools

Mike Craft <mike.craft@bvcps.net> Mar 19
to George

Thanks George!

...

Appendix D

Teacher Survey

Welcome to My Survey

Thank you for participating! This survey has no more than 10 questions should take less than 3 minutes to complete.
Please use the navigation buttons at the bottom of the page, and not the web browser, to navigate through the survey. You may exit the survey at any time by clicking on "Exit this survey" at the top of the page.

Please read the consent agreement below.
If you agree, click **next** at the bottom of the page.
If you do not agree, click the **exit survey** button at the top of the page.

Consent Form

LEARNING STRATEGIES OF SECONDARY SCHOOL TECHNOLOGY EDUCATION TEACHERS AND THEIR STUDENTS

Michael Craft
Liberty University
Educational Leadership

You are invited to be in a research study of Virginia high school Technology Education teachers and their students. You were selected as a possible participant because you teach high school level Technology Education courses. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

Mike Craft, a doctoral candidate in the educational leadership program at Liberty University is conducting this study.

Background Information: The purpose of this study is to compare the learning strategies of Technology Education teachers with the learning strategies of their students. I hope to determine if there is a significant association between the learning strategies of Technology Education teachers and their students as a whole, and also between teachers and students in the different International Technology and Engineering Educators Association (ITEEA) content areas.
Procedures: If you agree to be in this study, I would ask you to do the following things:
a. Complete an online survey using SurveyMonkey that will collect general information about yourself and your association with Technology Education. The survey will also determine your preferred learning strategy using the Assessing the Learning Strategies of Adults (ATLAS) instrument incorporated into the survey. You will have the opportunity to enter a prize drawing. The survey should take less than five minutes to complete.
b. Allow your high school Technology Education students to voluntarily participate in the study.
c. Read a researcher provided script to your students that explains the purpose of the study, the risks, the right to not participate without penalty, and what will be asked of the students that agree to participate.
d. Provide those students that agree to participate with an Internet connected device to take a survey using SurveyMonkey. Read researcher provided instructions to the participating students. Allow approximately 5 minutes of class time for the students to complete the survey and register for a prize drawing.

Risks and Benefits of being in the Study:

The study has several risks: The risks of this study are minimal. The risks are no more than the participant would encounter in everyday life.

The benefits to participation are: The participant will determine their preferred learning strategy using the ATLAS theory and instrument. A description of their learning strategy will be provided, which may lead to improved awareness and understanding of the participant's own thought process that may be used to develop new techniques for learning and teaching.

Participants will have the opportunity to enter a prize drawing. Winners will be randomly selected at the end of the study.

It is hoped that the results of this study will add to the existing body of knowledge in regards to learning strategies and Technology Education. The resulting data may lead to improved teaching strategies, new techniques for differentiated instruction, a better understanding of the role learning strategies have in Technology Education, and an increase in student achievement.

Compensation: You will not receive any guaranteed compensation for participating in this study. Participants will have the opportunity to enter a prize drawing, however participants are not automatically entered in the drawing, and not all participants will receive a prize.

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely on the researcher's computer, and only the researcher will have access to the records. Data on individual participants will be erased after three years and individual data will not be used in other studies.

Contacts and Questions: The researcher conducting this study is Michael Craft. You may ask any questions you have now. If you have questions later, you are encouraged to contact him at mrcraft2@liberty.edu, or at 540-460-4474 (texts accepted). My advisor is Dr. Kurt Michael, (xxx) xxx-xxxx, kmichael9@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information to keep for your records.

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

* What is your gender?

- ◯ Female
- ◯ Male

* What is the highest degree you have received?

- ◯ Associate's Degree
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ Advanced Studies degree
- ◯ Doctorate degree

* What is your ethnicity or race?

- ◯ American Indian or Alaskan Native
- ◯ Asian
- ◯ Black or African-American
- ◯ Hispanic or Latino
- ◯ Native Hawaiian or other Pacific Islander
- ◯ Unspecified
- ◯ White

What is your age in years?

____

How many years of experience do you have teaching Technology Education?

____

What Technology Education courses are you teaching? (Select all that apply)

- [ ] Advanced Drawing and Design
- [ ] Aerospace Engineering
- [ ] Aerospace Technology I
- [ ] Aerosace Technology II
- [ ] Architectural Drawing and Design
- [ ] Bioengineering
- [ ] Biotechnology Foundations in Technology Education
- [ ] Civil Engineering and Architecture
- [ ] Communication Systems
- [ ] Computer Integrated Manufacturing
- [ ] Construction Technology
- [ ] Digital Electronics
- [ ] Digital Visualization
- [ ] Electronics Systems
- [ ] Energy and Power
- [ ] Engineering Analysis and Applications
- [ ] Engineering Concepts and Processes
- [ ] Engineering Design and Development
- [ ] Engineering Drawing and Design
- [ ] Engineering Explorations
- [ ] Engineering Practicum
- [ ] Engineering Studies
- [ ] Forensic Technology
- [ ] Gateway to Technology
- [ ] Geospatial Technology
- [ ] Global Logistics & Enterprise Systems
- [ ] Graphic Communication Systems
- [ ] Imaging Technology
- [ ] International Baccalaureate Design Technology
- [ ] Introduction to Engineering Design
- [ ] Manufacturing Systems
- [ ] Materials and Processes Technology
- [ ] Modeling and SimulationTechnology
- [ ] Power and Transportation
- [ ] Principles of Engineering
- [ ] Principles of Technology
- [ ] Production Systems
- [ ] Renewable Energy
- [ ] Sustainability and Renewable Technologies
- [ ] Technical Drawing and Design
- [ ] Technology Assessment
- [ ] Technology Education Dual Enrollment
- [ ] Technology Education - Development
- [ ] Technology Education - Preparation
- [ ] Technology Foundations
- [ ] Technology of Robotic Design
- [ ] Technology Transfer
- [ ] Video and Media Technology

Other (please specify)

At this point you will determine your preferred learning strategy category using the Assessing The Learning strategies of Adults (ATLAS) instrument.

Directions: The following pages have questions on them related to learning in real-life situations in which you control the learning situation. *These are situations that are not in a formal school.* For each one, select the answer that best fits you. Continue this process until you learn your group name and the description of your group.

When considering a new learning activity such as learning a new craft, hobby, or skill for use in my personal life,

- ◯ I like to identify the best possible resources such as manuals, books, modern information sources, or experts for the learning project.
- ◯ I usually will not begin the learning activity until I am convinced that I will enjoy it enough to successfully finish it.

It is important for me to:

- ◯ Focus on the end result and then set up a plan with such things as schedules and deadlines for learning it.
- ◯ Think of a variety of ways of learning the material.

I like to:

- ◯ Involve other people who know about the topic in my learning activity.
- ◯ Determine the best way to proceed with a learning task by evaluating the results that I have already obtained during the learning task.

I like to:

- ◯ Involve other people who know about the topic in my learning activity.
- ◯ Structure the information to be learned to help remind me that I can successfully complete the learning activity.

You are a Navigator!

Navigators…

Are focused learners that like to devise a plan for learning and follow the plan.
Like order and structure.
Desire clear learning objectives, with schedules and deadlines.
Expect and appreciate prompt feedback.
Like to challenge other peoples ideas, and asks them to explain how they came up with their ideas.
Do not really like working in groups, unless there is an expert guiding the group.
Like to use different organizational tools such as binders, highlighters, and notebooks.

They also have these characteristics…

May need some extra time to complete assignments, since they prefer to gather a lot of information.
Start learning tasks by identifying resources to successfully complete the task.
Like learning activities to be efficient and effective.
Base decisions on their own beliefs, values, abilities, and experiences.
Enjoy debating, and use debate to gather information.

When instructing Navigators…

Schedules and deadlines are helpful. Outlining objectives and expectations, summarizing main points, giving prompt feedback, and allowing opportunity for debate, help Navigators learn new material.

Sanders, P., & Conti, G. (2012). Identifying individual differences: A cognitive styles tool. *Journal of Adult Education, 41* (2), 43-64.

Please click "Next" to end the survey.

I like to:

◯ Set up a plan for the best way to proceed with a specific learning task.

◯ Check out the resources that I am going to use to make sure that they are the best ones for the learning task.

You are a Problem Solver!

Problem Solvers…

Enjoy generating alternatives.
Prefer to approach the learning task in their own way without rigid directions and strict supervision.
Like telling stories.
Are very descriptive when providing answers and like to provide examples.
View trial and error as an effective way to learn new things.
Constantly look for new and better ways to do things.
When interrupted, have trouble getting started again.
Are good with abstract ideas and often use symbols.

They also have these characteristics…

It sometimes looks like they are procrastinating, but are really just searching for alternatives.
Like to gather information by talking to other students.
Tend to want one-on-one dialog with the instructor to receive more information.
May require more instructor time.
Enjoy interacting with other students.
Often end up learning about content that was not part of the original lesson.

When instructing Problem Solvers:

Provide an environment of practical experimentation, give examples from personal experience, assess learning with open-ended questions, and include problem- solving activities

Sanders, P., & Conti, G. (2012). Identifying individual differences: A cognitive styles tool. *Journal of Adult Education, 41*(2), 43-64.

Please click "Next" to end the survey.

You are an Engager!

Engagers…

Think learning should be fun.
Must feel that a learning activity is worth doing.
Enjoy building relationships with their instructor and other learners.
Get bored quickly if they are not actively engaged.
Take joy and delight in achieving new learning accomplishments.
Appreciate teachers that get excited about learning and show their human side.
Enjoy working in teams.

They also have these characteristics…

Think working with others is as important as the content learned.
However, Engagers are not really interested in a debate with other students, or creating a dialog.
Would rather receive information passively.
Think feeling is an important aspect of learning.

When instructing Engagers…

Provide an atmosphere that creates a relationship between the learner, the task, and the teacher. Focus on learning rather than evaluation and encourage personal exploration for learning. Group work also helps to create a positive environment.

Sanders, P., & Conti, G. (2012). Identifying individual differences: A cognitive styles tool. *Journal of Adult Education, 41*(2), 43-64.

Please click "Done" to end the survey.

Appendix E

Student Survey

Welcome to My Survey

Thank you for participating! The survey has no more than 10 questions and should take less than 3 minutes to complete.
Please use the navigation buttons at the bottom of the page, and not the web browser, to navigate through the survey. You may exit the survey at any time by clicking on "Exit this survey" at the top of the page.

Please read the consent agreement below.
If you agree, click **"next"** at the bottom of the page.
If you do not agree, click the **"exit survey"** button at the top of the page.

Assent of Student to Participate in a Research Study

What is the name of the study and who is doing the study?
The name of this study is Learning Strategies of Secondary School Technology Education Teachers and Their Students. Mr. Mike Craft, a Technology Education teacher and Liberty University student, is conducting this study.
Why am I doing this study?
I am interested in studying the learning strategies of Technology Education teachers and their students to see if there is an association between the two groups. Hopefully the results will be used to improve instruction in Technology Education classes.
Why am I asking you to be in this study?
You are being asked to be in this research study because you are currently taking a high school level Technology Education course, and your teacher has agreed to participate.
If you agree, what will happen?
If you are in this study, you will be asked to complete a survey. The survey will ask general questions about you and the Technology Education course you are taking. You will also answer questions that will place you in a learning strategy category. All answers will be completely anonymous and confidential.
Do you have to be in this study?
No, you do not have to be in this study. If you want to be in this study, then tell your teacher. If you don't want to, it's OK to say no. The researcher will not be angry. You can say yes now and change your mind later. It's up to you.
Do you have any questions?
You can ask questions any time. You can ask now. You can ask later. You can email the researcher. If you do not understand something, please ask the researcher to explain it to you again.

Contact Information

Michael Craft (researcher)
Email - mrcraft2@liberty.edu

Dr. Kurt Michael (faculty advisor)
Email - kmichael9@liberty.edu

Liberty University Institutional Review Board,
1971 University Blvd, Suite 1837, Lynchburg, VA 24515
or email at irb@liberty.edu.

* What is your gender?

- ◯ Female
- ◯ Male

What is your ethnicity or race?

- ◯ American Indian or Alaskan Native
- ◯ Asian
- ◯ Black or African-American
- ◯ Hispanic or Latino
- ◯ Native Hawaiian or other Pacific Islander
- ◯ White
- ◯ Unspecified

* What grade are you in? (9,10,11, or 12)

____

* What is your age in years?

____

What high school level Technology Education course are you taking this period?

- ◯ Advanced Drawing and Design
- ◯ Aerospace Engineering
- ◯ Aerospace Technology I
- ◯ Aerospace Technology II
- ◯ Architectural Drawing and Design
- ◯ Bioengineering
- ◯ Biotechnology Foundations in Technology Education
- ◯ Civil Engineering and Architecture
- ◯ Communication Systems
- ◯ Computer Integrated Manufacturing
- ◯ Construction Technology
- ◯ Digital Electronics
- ◯ Digital Visualization
- ◯ Electronics Systems
- ◯ Energy and Power
- ◯ Engineering Analysis and Applications
- ◯ Engineering Concepts and Processes
- ◯ Engineering Design and Development
- ◯ Engineering Drawing and Design
- ◯ Engineering Explorations
- ◯ Engineering Practicum
- ◯ Engineering Studies
- ◯ Forensic Technology
- ◯ Gateway to Technology
- ◯ Geospatial Technology
- ◯ Global Logistics & Enterprise Systems
- ◯ Graphic Communication Systems
- ◯ Imaging Technology
- ◯ International Baccalaureate Design Technology
- ◯ Introduction to Engineering Design
- ◯ Manufacturing Systems
- ◯ Materials and Processes Technology
- ◯ Modeling and Simulation Technology
- ◯ Power and Transportation
- ◯ Principles of Engineering
- ◯ Principles of Technology
- ◯ Production Systems
- ◯ Renewable Energy
- ◯ Sustainability and Renewable Technologies
- ◯ Technical Drawing and Design
- ◯ Technology Assessment
- ◯ Technology Education Dual Enrollment
- ◯ Technology Education - Development
- ◯ Technology Education - Preparation
- ◯ Technology Foundations
- ◯ Technology of Robotic Design
- ◯ Technology Transfer
- ◯ Video and Media Technology

Other (please specify)

[ ]

At this point you will determine your preferred learning strategy category using the Assessing The Learning strategies of Adults (ATLAS) instrument.

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- ◯ I usually will not begin the learning activity until I am convinced that I will enjoy it enough to successfully finish it.

It is important for me to:

- ◯ Focus on the end result and then set up a plan with such things as schedules and deadlines for learning it.
- ◯ Think of a variety of ways of learning the material.

I like to:

- ◯ Involve other people who know about the topic in my learning activity.
- ◯ Determine the best way to proceed with a learning task by evaluating the results that I have already obtained during the learning task.

I like to:

- ◯ Involve other people who know about the topic in my learning activity.
- ◯ Structure the information to be learned to help remind me that I can successfully complete the learning activity.

You are a Navigator!

Navigators…

Are focused learners that like to devise a plan for learning and follow the plan.
Like order and structure.
Desire clear learning objectives, with schedules and deadlines.
Expect and appreciate prompt feedback.
Like to challenge other peoples ideas, and asks them to explain how they came up with their ideas.
Do not really like working in groups, unless there is an expert guiding the group.
Like to use different organizational tools such as binders, highlighters, and notebooks.

They also have these characteristics…

May need some extra time to complete assignments, since they prefer to gather a lot of information.
Start learning tasks by identifying resources to successfully complete the task.
Like learning activities to be efficient and effective.
Base decisions on their own beliefs, values, abilities, and experiences.
Enjoy debating, and use debate to gather information.

Sanders, P., & Conti, G. (2012). Identifying individual differences: A cognitive styles tool. Journal of Adult Education, 41(2), 43-64.

Please click "Next" to end the survey.

I like to:

- ◯ Set up a plan for the best way to proceed with a specific learning task.
- ◯ Check out the resources that I am going to use to make sure that they are the best ones for the learning task.

You are a Problem Solver!

Problem Solvers…

Enjoy generating alternatives.
Prefer to approach the learning task in their own way without rigid directions and strict supervision.
Like telling stories.
Are very descriptive when providing answers and like to provide examples.
View trial and error as an effective way to learn new things.
Constantly look for new and better ways to do things.
When interrupted, have trouble getting started again.
Are good with abstract ideas and often use symbols.

They also have these characteristics…

It sometimes looks like they are procrastinating, but are really just searching for alternatives.
Like to gather information by talking to other students.
Tend to want one-on-one dialog with the instructor to receive more information.
May require more instructor time.
Enjoy interacting with other students.
Often end up learning about content that was not part of the original lesson.

Sanders, P., & Conti, G. (2012). Identifying individual differences: A cognitive styles tool. Journal of Adult Education, 41(2), 43-64.

Please click "Next" to end the survey.

You are an Engager!

Engagers…

Think learning should be fun.
Must feel that a learning activity is worth doing.
Enjoy building relationships with their instructor and other learners.
Get bored quickly if they are not actively engaged.
Take joy and delight in achieving new learning accomplishments.
Appreciate teachers that get excited about learning and show their human side.
Enjoy working in teams.

They also have these characteristics…

Think working with others is as important as the content learned.
However, Engagers are not really interested in a debate with other students, or creating a dialog.
Would rather receive information passively.
Think feeling is an important aspect of learning.

Sanders, P., & Conti, G. (2012). Identifying individual differences: A cognitive styles tool. Journal of Adult Education, 41(2), 43-64.

Please click "Done" to end the survey.

Appendix F

Survey Directions Read to Class

You have been invited to participate in a research study that determines your preferred learning strategy and compares it to other Technology Education students and teachers in Virginia. The survey has no more than 10 questions and should not take more than three minutes to complete. All answers will be completely anonymous and confidential. You are not required to participate in the study, and may opt-out if you want to, without penalty. Also, you can exit the survey once you have started if you change your mind. Are there any questions? If you agree to participate, the link to the survey is http://testudent.weebly.com (teachers may provide the link in whatever format they prefer). You may begin when ready.

Appendix G

Email to High School Teachers

(Technology Education Teacher)

I am Mike Craft, a former Technology Education teacher, and now the principal and CTE supervisor at XXXXXX High School. I am conducting research on the preferred learning strategies of Technology Education students and teachers in Virginia as part of my doctoral program in educational leadership at Liberty University. I hope to determine if there is a significant association between the learning strategies of Tech Ed teachers and Tech Ed students as a whole, and also between the learning strategies of students taking different Tech Ed courses. The survey has no more than 14 questions and should not take more than three minutes to complete. Teacher participants will have the opportunity to enter a drawing for one of three $50 Lowes gift certificates.

Please use this link to take the survey: http://teteacher.weebly.com .

I would also like to have your students participate in the study. They will take a survey similar to the teacher survey that also has 12 or fewer questions, and takes less than three minutes to complete. The survey is anonymous and confidential. Hopefully this will provide an opportunity for your students to gain insight as to how they prefer to learn, and also provide you with useful information about your students.

The Institutional Review Board (IRB) has determined that parental consent is not required for students to take this survey, however they require the opportunity for your students to opt out of the study (form attached). If you are willing for your students to participate in the study, I will be glad to contact the appropriate person or persons in your school system to obtain permission.

Please use this email address for any questions you may have: mrcraft2@liberty.edu. Research results will be available at the conclusion of the study. I have attached an opt-out form for students, a copy of the student survey, and an optional script to be read to your students.

Thank You!
Mike

Appendix H

Email for Non-Responding High School Teachers

If you can make a few minutes in this busy time of year, I need help with my Technology Education surveys. I am still collecting student data, however if you can't make it a class activity, your response to the teacher survey would really help me. The survey will be open until May 30th. Thank you in advance! Mike

Original email:

I am Mike Craft, a former Technology Education teacher, and now the principal and CTE supervisor at XXXXXX High School. I am conducting research on the preferred learning strategies of Technology Education students and teachers in Virginia as part of my doctoral program in educational leadership at Liberty University. I hope to determine if there is a significant association between the learning strategies of Tech Ed teachers and Tech Ed students as a whole, and also between the learning strategies of students taking different Tech Ed courses. The survey has no more than 14 questions and should not take more than three minutes to complete. Teacher participants will have the opportunity to enter a drawing for one of three $50 Lowes gift certificates.

Please use this link to take the survey: http://teteacher.weebly.com .

I would also like to have your students participate in the study. They will take a survey similar to the teacher survey that also has 12 or fewer questions, and takes less than three minutes to complete. The survey is anonymous and confidential. Hopefully this will provide an opportunity for your students to gain insight as to how they prefer to learn, and also provide you with useful information about your students.

The Institutional Review Board (IRB) has determined that parental consent is not required for students to take this survey, however they require the opportunity for your students to opt out of the study (form attached). If you are willing for your students to participate in the study, I will be glad to contact the appropriate person or persons in your school system to obtain permission.

Please use this email address for any questions you may have: mrcraft2@liberty.edu. Research results will be available at the conclusion of the study. I have attached an opt-out form for students, a copy of the student survey, and an optional script to be read to your students.

Thank You!
Mike

Appendix I

IRB Approval for Research

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

November 14, 2018

Michael Craft
IRB Approval 2488.111418: Learning Strategies of Secondary School Technology Education Teachers and Their Students

Dear Michael Craft,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

> Your study involves surveying or interviewing minors, or it involves observing the public behavior of minors, and you will participate in the activities being observed.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

Appendix J

Student Opt-Out Form

The Liberty University Institutional
Review Board has approved
this document for use from
11/14/2018 to 11/13/2019
Protocol # 2488.111418

PARENT/GUARDIAN OPT-OUT FORM

Learning Strategies of Secondary School Technology Education Teachers and Their Students
Michael Craft
Liberty University
School of Education

Your child is invited to be in a research study that compares the learning strategies of students taking Technology Education classes with the learning strategies of Technology Education teachers in Virginia. He or she was selected as a possible participant because your child is currently enrolled in a high school level Technology Education course. Please read this form and ask any questions you may have before agreeing to allow him or her to be in the study.

Michael Craft, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine if Technology Education students have the same preferred learning strategies as Technology Education teachers.

Procedures: If you agree to allow your child to be in this study, I would ask him or her to complete an online survey that includes the following information: gender, ethnicity, grade level, age, and the Technology Education course that they are taking. The Assessing the Learning Strategy of Adults (ATLAS) instrument is incorporated into the survey to determine the student's preferred learning strategy. The entire survey is 10 multiple choice responses, and should take less than five minutes to complete.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: Participants should not expect to receive a direct benefit from taking part in this study. Benefits to society include the potential to improve instructional practices and curriculum development for Technology Education students by knowing their preferred instructional strategies.

Compensation: Your child will not be compensated for participating in this study.

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records. To protect privacy, data will be collected on individual electronic devices, and I will not be able to link any data collected to specific participants. Data will be stored on a password locked computer and may be used in future presentations. After three years, all electronic records will be deleted.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with

Liberty University. If you decide to allow your child to participate, he or she is free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

How to Withdraw from the Study: If your child chooses to withdraw from the study, your child should exit the survey and close his or her internet browser. Your child's responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is Michael Craft. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at mrcraft2@liberty.edu . You may also contact the researcher's faculty advisor, Dr. Kevin Struble, at kdstruble@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Opt-Out Statement: I have read and understood the above information. I have asked questions and have received answers. I DO NOT want my child to participate in this research study.

____

Signature of Parent Date

Appendix K

Permission to Conduct Study

April 16, 2019

Dr. Xxxxxxx Xxxxxxxxx
Superintendent
Xxxxxxxxxx County Schools
XXXX Xxxxxxxxxxx Rd.
Xxxxxxxxx, VA XXXXX

Dear Dr. Xxxxxxxx:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate in educational leadership. The title of my research project is Learning Strategies of Secondary School Technology Education Teachers and Their Students, and the purpose of my research is to determine if there is a significant association between the learning strategies of technology education teachers and technology education students as a whole, and also between the learning strategies of students taking different technology education courses.

I am writing to request your permission to conduct my research at Xxxxxxxxx Xxxxxx High School. Participants will be asked to go to http://testudent.weebly.com and click on the link provided to complete a 12 question survey (attached). Participants will be presented with a parent/guardian opt-out form prior to participating (attached). Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please provide a signed statement on official letterhead indicating your approval. Please feel free to attach a digital copy to this email. A permission letter document is attached for your convenience.

Sincerely,

Mike Craft

Appendix L

Template to Approve Request

[Insert Date]

Mr. Mike Craft
XXX Xxxx Xxxxx Road
Xxxxx Xxxxx, VA XXXXX

Dear Mr. Craft:

After careful review of your research proposal entitled Learning Strategies of Secondary School Technology Education Teachers and Their Students, I have decided to grant you permission to conduct your study at Xxxxxxx Xxxxxx High School.

Sincerely,

Dr. Xxxxxx Xxxxxx
Superintendent
Xxxxxxx Xxxxxx Public Schools

Appendix M

Technology Education Course Descriptions

Advanced Drawing and Design - Advanced Drawing and Design students use graphic language for use in product design and technical illustration. Students research design-related fields as to the role of advanced drawing and design in current industry practices. Students apply their knowledge of drawing design by creating 3-D models, designing real-world technologies in CADD, constructing physical models, and creating multimedia presentations describing design processes (CTE Resource Center, 2019a).

Aerospace Engineering - Aerospace Engineering is a course designed for Project Lead the Way where students are taught concepts in aerodynamics, astronautics, space-life sciences, and systems engineering using hands-on projects and engineering problems (CTE Resource Center, 2019b).

Aerospace Technology I – Aerospace Technology uses a hands-on approach to introduce flight, space, and supporting technologies. Students explore different aspects of the aviation and space industries, including the history and safety issues involved, the theoretical and engineering concepts of flight, and the operations that make flight possible (CTE Resource Center, 2019c).

Aerospace Technology II – Aerospace Technology II builds on the concepts of Aerospace Technology I by providing an advanced exploration of the aerospace industry. The students use practical application and problem-solving methods to explore aircraft operations, design, safety, and maintenance. Students also explore outer space technologies such as rocket technologies and the requirements of living and working in space (CTE Resource Center, 2019d).

Architectural Drawing and Design – Architectural drawing and design explores the different aspects of building construction, including construction techniques, building codes, and the foundations of building design. Students read and create working construction drawings, including utility design, using both board drawing and Computer Aided Drafting and Design (CADD). Projects also include model building and illustrations (CTE Resource Center, 2019e).

Bioengineering – Bioengineering studies bioengineering applications in the fields of agriculture, information and communication, manufacturing, and medicine, including the design and manufacturing of bioengineered products. The course includes assignments where students use the engineering design process to design products such as artificial limbs or producing electronic instruments used in biotechnology (CTE Resource Center, 2019f).

Biotechnology Foundations in Technology Education – This course focuses on different techniques to improve plants and animals by modifying living organisms or parts of living organisms, including the development of microorganisms. Students explore biotechnology career fields using activities related to medicine, DNA analysis, and the environment (CTE Resource Center, 2019g).

Civil Engineering and Architecture – Civil Engineering and Architecture is a Project Lead the Way course where students collaborate to develop plans for community-based buildings, including making presentations detailing the designs (CTE Resource Center, 2019h).

Communication Systems - Communication Systems is an introductory course that explores different areas of communication technology such as video and related media, imaging technology, graphic communication, technical design, and other modes of communication. Students explore existing communication technologies using critical thinking and problem solving skills. Students also learn the impacts of communication and information technologies, including finding reliable sources of information, and the careers in the communication and information field (CTE Resource Center, 2019i).

Computer Integrated Manufacturing – This is a Project Lead the Way course where students learn the concepts of automated manufacturing and robotics using computer modeling software to produce 3-D designs that can be controlled by a computer.

Construction Technology – Construction Technology students design and build scale or full-size structures to explore all aspects of the construction industry. They explore each phase of the building process including design (architects, engineers, etc.), production (masons, carpenters, etc.), and management (builders, contractors, etc.) (CTE Resource Center, 2019k).

Digital Electronics – Digital Electronics is a Project Lead the Way course where students design, test, and construct circuits and devices using computer simulation as part of an exploration of the principles of electronics. They also explore control-system technology using sequential logic and digital circuitry (CTE Resource Center, 2019l).

Digital Visualization - Digital Visualization is a computer animation course where students incorporate graphics and other design concepts to create animations that represent real-world applications. Students use 3-D and interactive animation software to demonstrate competencies associated with the animation industry. Students solve animation problems involving storyboarding, lighting concepts, environmental geometry, mapping, and 3-D object manipulation (CTE Resource Center, 2019m).

Electronics Systems – Electronics Systems is a three level course that allows students to explore principles of electricity through projects and experiments. Students build AC and DC circuits, and make electronic projects and devices. As students progress through the course levels, the theories and devices become more complex, with students studying circuits used in computers, televisions, robotic programming, etc. (CTE Resource Center, 2019n).

Energy and Power – Students explore and analyze energy sources for the production of electricity, using theoretical and hands-on assignments. The assignments include how electricity is generated, transmitted, and distributed (CTE Resource Center, 2019o).

Engineering Analysis and Applications – This is the second course in a sequence of four courses that allows students to apply the engineering design process to real-world applications of engineering. This course examines chemical, civil, electrical, and mechanical engineering systems, including ethical considerations. Hands-on projects are used in addition to producing reports, proposals, and presentations (CTE Resource Center, 2019p).

Engineering Concepts and Processes – This is the third course in a sequence of four courses that allows students to apply the engineering design process to real-world applications of engineering. Hands-on projects are used in addition to producing reports, proposals, and presentations. Students work as a team, perform case studies, manage projects, and apply their engineering skills using logic and problem solving (CTE Resource Center, 2019q).

Engineering Design and Development – This is the final course in the Project Lead the Way engineering sequence where teams of students work together to research, design, and construct solutions to engineering problems. This experience is meant to synthesize the students' knowledge of engineering and apply it to real-world problems (CTE Resource Center, 2019r).

Engineering Drawing and Design – Engineering Drawing and Design builds on the skills learned in Technical Drawing and Design and explores the engineering design process. Students use CADD for technical illustration, product design, structural drawings, and assembly directions (CTE Resource Center, 2019s).

Engineering Explorations - This is the first course in a sequence of four courses that allows students to apply the engineering design process to real-world applications of engineering. The course focuses on engineering fundamentals, including the history or engineering, major technical breakthroughs, different types of engineering, and careers in engineering. Hands-on projects are used in addition to producing reports, proposals, and presentations (CTE Resource Center, 2019t).

Engineering Practicum - This is the final course in a sequence of four courses that allow students to apply the engineering design process to real-world applications of engineering. Students use the knowledge and skills acquired in the previous three courses to complete a practicum project. Students explore a variety of the different engineering specialties and determine if they are good candidates for a career in engineering (CTE Resource Center, 2019u).

Engineering Studies – Engineering Studies is a course designed for students that intend to seek a post-secondary degree in engineering. The course emphasizes the rigorous demands of becoming an engineer, and emphasizes that students must integrate mathematics with science, English, and other courses to be successful. The course also provides brainstorming and problem solving experiences using real-world engineering problems (CTE Resource Center, 2019v).

Forensic Technology – This course is an introduction to forensic science, which is a science that establishes facts in criminal cases using scientific analysis and high-tech investigative techniques. Students explore careers such as forensic pathology, toxicology, forensic psychology, and entomology, among others (CTE Resource Center, 2019w).

Geospatial Technology – Geospatial Technology is a two-level exploratory course where students study and use global positioning systems (GPS), geographic information systems (GIS), remote sensing (RS), and mobile technologies. Students use these technologies to collect data on the natural and man-made world, and use these data to solve human challenges (CTE Resource Center, 2019x).

Global Logistics and Enterprise Systems – This is a two-level exploratory course on logistics, which is moving goods from one place to another efficiently. The first course introduces students to global logistics using a virtual enterprise systems environment where they learn enterprise resource planning. The second course expands on the first by introducing material handling, transportation issues, facility locations, international logistics, and related topics (CTE Resource Center, 2019y).

Graphic Communications Systems - Graphic Communications Systems emphasizes the use of visual modes of communication to convey images or information. Students learn a variety of design processes and techniques such as technical design, photo manipulation, and real-world application of graphics. Students use graphic design programs, digital cameras, offset printing, screen-printing, and a variety of other mediums to create products that relate to current graphic communication technologies (CTE Resource Center, 2019z).

Imaging Technology - Imaging Technology is a photography course that emphasizes digital imaging. Students learn the history of photography, technologies related to photography, and the different modes of recording photographic images. Editing software, such as Photoshop, is used to manipulate images. Students also learn the modes of sharing images, and the ethical and legal issues of creating and sharing photographic images (CTE Resource Center, 2019aa).

Introduction to Engineering Design – This is a Project Lead the Way course where students use 3-D modeling software to learn the engineering design process. Students solve design problems by developing and creating product models (CTE Resource Center, 2019bb).

Manufacturing Systems – Manufacturing systems is an exploratory course that provides experiences in the various careers available in manufacturing. Students create manufactured products, as individuals and in teams, which demonstrate the different aspects of the manufacturing process, such as materials processing, safety, production, quality, and productivity (CTE Resource Center, 2019cc).

Materials and Processes Technology – The focus of this course is on physical materials and processes used to construct manufactured products, and also to conduct experiments. Students use tools and equipment to analyze, test, and process manufacturing materials such as metals, plastics, woods, ceramics, and composite materials (CTE Resource Center, 2019dd).

Modeling and Simulation Technology – Students solve real-world problems in science, technology, engineering, and mathematics (STEM), using modeling, simulation, and game development software. Students gain an understanding of tools, processes, and systems used in modeling and simulation technology. The curriculum includes work in 3-D modeling, game programming, and testing engineering designs (CTE Resource Center, 2019ee).

Power and Transportation – Power and transportation explores the way that energy is converted into power and how this power is used in electrical, fluid, and mechanical devices. Students learn the theories of energy transfer and how energy is controlled through research, experimentation, and hands-on application (CTE Resource Center, 2019ff).

Principles of Engineering – This course is the foundation for students in Project Lead the Way schools to learn about engineering problem solving and the engineering profession. Fundamental mathematical and scientific concepts related to engineering are studied, along with impacts of engineering and ethical implications (CTE Resource Center, 2019gg).

Principles of Technology – Principles of technology is a two-year sequence of courses that explores the seven technical principles that underlie modern technical systems: energy, power, work, rate, force, resistance, and force transformers. Each of these technical principles is applied to the operation of fluid, mechanical, electrical, and thermal systems used in modern equipment (CTE Resource Center, 2019hh).

Production Systems – Production systems is a course in manufacturing where students explore the relationship between production and society. Students create design portfolios, construct prototypes, and use automation to solve technological problems related to manufacturing (CTE Resource Center, 2019ii).

Renewable Energy – Renewable energy explores renewable energies through the study of how they work and how they can be used. Students select different renewable energy technologies and use hands-on assignments to demonstrate their design and function (CTE Resource Center, 2019jj).

Sustainability and Renewable Technologies – This course explores how the world's resources affect the areas of culture, economics, and the environment. Students address issues affecting the health of our environment and explore solutions to efficient building design, sustainable agriculture, and renewable energy sources (CTE Resource Center, 2019kk).

Technical Drawing and Design – This course is recommended for future architecture or engineering students. Students learn about technical drawing design using board drawing and/or CADD techniques, where they explore sketching, technical drawing, design, modeling, and related technologies (CTE Resource Center, 2019ll).

Technology Assessment - Technology Assessment is designed to be one of the final courses in the secondary Technology Education sequence. The course uses students' cumulative knowledge from previous experience in Technology Education, along with related educational experience, to analyze the impact of various technologies on the world. Students research different technologies and then predict how these technologies may transform in the future.

Based on this research, students design new products and/or technologies and present them in a paper, prototype, or group presentation (CTE Resource Center, 2019mm).

Technology Foundations – Technology foundations is a beginning high school course that provides experience in the foundational technologies through laboratory experiences, where students learn how and why technology works. Students work in groups to create new ideas and innovations. They also design and build technological systems using engineering design principles (CTE Resource Center, 2019nn).

Technology of Robotic Design – This course studies how computers are applied in the areas of transportation, manufacturing, and communication systems. Some of the learning activities include robotics, computer-aided manufacturing (CAM), computer-aided design, and control of electromechanical devices (CTE Resource Center, 2019oo).

Technology Transfer – Students learn how technology transfer occurs when existing technology used for one purpose is used for a different function. Working in groups, students combine technologies in energy and power, construction, manufacturing, transportation, etc. to create new purposes for the technologies (CTE Resource Center, 2019pp).

Video and Media Technology - Video and Media Technology is a course that explores all aspects of the video/film industry, and the related media that contribute to video/film technologies. Students research preproduction, production, and postproduction phases of video and use them to plan and produce video projects that are relevant to current industry practices. Students use a variety of video and audio equipment to record information, edit the content using a variety of film editing programs, and communicate the information through appropriate distribution channels (CTE Resource Center, 2019qq).