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# Technological Literacy Programs in Elementary School

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# TECHNOLOGICAL LITERACY PROGRAMS IN ELEMENTARY SCHOOL

by

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**ABSTRACT**

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Technology and engineering design education is offered as an elective in most secondary school curriculums, however a primary school curriculum is not common. The Standards for Technological Literacy (ITEEA, 2007), which focus on technological literacy and engineering design, are not typically included in primary education.

The objectives of this study are to determine if teachers and administrators think technology and engineering education provide new opportunities for elementary students, how they feel about technology and engineering education, and what obstacles exist for successful implementation. A literature review provided the background on federal, state, and local technology initiatives that exist for Virginia public schools. It also defined technology standards that exist and how they have been incorporated in state curriculum requirements at the elementary level.

A survey was used for both teachers and administrators at each elementary school in the sample. Data was collected from seventy-seven participants from twenty-four elementary schools. The results indicate ninety-two percent of respondents agree that implementation of a technology and engineering design education program would provide new educational opportunities at their schools. Eighty-seven percent of respondents feel it is essential to learn about technology and engineering design in elementary school.

Participants felt that students do use different types of technology in the classroom for finding information. But do not use technology and the engineering design process to troubleshoot and find solutions to problems through facilitated projects. Only a quarter of respondents were satisfied about the current technology and engineering educational opportunities at their schools.

Teachers and administrators indicated that the biggest obstacle that exists for successful implementation of a technology and engineering education curriculum is lack of funding, followed by a lack of materials.

## TABLE OF CONTENTS

## LIST OF TABLES

# CHAPTER I
# INTRODUCTION

All educational programs should strive to achieve technological literacy with their students. Technology is defined as the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment (Technology, n.d.). ITEEA (2007) defines technology as the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants. Children are immersed with technology from the day they are born. Technological literacy is defined as the ability to use, manage, assess, and understand technology (ITEEA, 2007). People learn to use and manage technology on a daily basis through trial and error to accomplish tasks more efficiently. However, learning how to assess and understand technology requires facilitated inquiry based instruction by knowledgeable individuals who can help students discover how technology works and how to create new technologies.

Technology and engineering education is offered as an elective in most secondary school curriculums in the United States, however a primary school technology and engineering education curriculum is not common. Each state defines specific standards related to using technology in primary education. However, the Standards for Technological Literacy are not typically included in primary education standards. This is a key factor to introducing and fostering inquiry based thinking skills in primary grade students. The more experience students have with the engineering design process, the more innovative the discoveries they might achieve in secondary school and beyond.

It is critical to find ways to incorporate technological literacy into primary education. School systems need to evaluate the current enrichment opportunities that exist to provide educational experiences outside the general core subjects and determine the feasibility of adding technology related problem solving to their programs. By offering technology and engineering education during the regular school day the maximum number of students are given the opportunity for enhancing their technological literacy.

## Statement of the Problem

The problem of this study was to determine the feasibility in offering technology and engineering design programs in the City of Chesapeake, Virginia to increase technological literacy in elementary school.

## Research Questions

The objectives of this study were to explore the following questions:

$RQ_1$. Do elementary teachers and administrators believe technology and engineering programming provides new educational opportunities for students?

$RQ_2$. What is the reaction to technology and engineering programming as an educational option among elementary teachers and school administrators?

$RQ_3$. What obstacles exist for implementation of a technology and engineering program?

## Background and Significance

The City of Chesapeake, Virginia, currently offers elementary students enrichment class time in physical education, art, music, media center/library, and computer lab on a weekly or bi-weekly basis. There is a dedicated teacher for each enrichment program area at each elementary school. During the 5th grade year students are given the opportunity to participate in a school based orchestra program for their music enrichment. This program meets for 45 minutes once a week. Students who opt not to participate have an extra weekly class with the school music teacher (CPS, 2015).

In the State of Virginia, technology content is currently incorporated into the elementary school computer technology, science, and history/social science standards of learning. The related standards primarily focus on using different types of technology to gain knowledge about a defined topic. The history and social science standards begin to explore the history of technology and its social impacts on our society. However, there are no defined standards related to learning about using the engineering design process to access and solve technological problems. In elementary school the computer lab enrichment program is the only defined technology program that exists (BoE VA, 2013). This program focuses on using computers to access information for educational purposes and is only part of comprehensive technology and engineering education.

The City of Chesapeake middle schools require all rising 6th graders to choose between orchestra, band, and exploratory as an elective when they enroll in classes. Exploratory program students enroll in one of the following each quarter: technology, art, teen living, and foreign language. The music program requires students to enroll in 6th grade to participate. Students may not join the orchestra or band in 7th grade without an audition. If students continue in the music program, they do not have an opportunity to take any of the exploratory electives, including technology, during middle school.

With technology evolving so quickly in the global marketplace, it is essential that students are able to quickly adapt to changing technologies, assess current technology and processes for problems and deficiencies, and have the ability to innovate new solutions to current problems. A broader understanding of technology (i.e. *Standards for Technological Literacy)* and the engineering design process provides the framework for these objectives. The earlier students are introduced to this process in school the more proficient they will be when they enter the workforce or higher education.

By introducing technology and engineering education in elementary schools, students are given the opportunity to learn about the engineering design process through inquiry based problem solving activities. These hands-on activities empower students to solve real world problems through experimentation and trial and error. By introducing technology and engineering education in elementary schools, students are more equipped to make informed decisions about what elective path they would enjoy in middle school.

## Limitations

The following limitations exist in this study:

1. Only teachers and administrators at the elementary school level were included in the population sample. Administrators and parents were not included due to time constraints.
2. Only schools in the City of Chesapeake were included in the population sample.
3. An online survey was the only instrument used for data collection due to time constraints.

## Assumptions

The following assumptions were made:

1. Exposure to technological problem solving is important. Students who are exposed to technology enrichment in elementary school are more likely to select exploratory elective programs in middle school.
2. Educators and administrators believe that computer lab is technology and engineering education. It is truly instructional technology, which is one part in broader technology and engineering education.
3. There is currently no inquiry based learning STEM curriculum in place in elementary schools in Chesapeake.
4. All elementary schools provide the option to 5th graders to participate in orchestra. If given an option, some students will choose technology and engineering education as an alternative to orchestra.
5. Technology Specialists can teach technology and engineering education to students with minimal additional training or certifications.

## Procedures

Extensive literature was reviewed to define the current technology standards and curriculum programming that exists in the State of Virginia at the elementary school levels. In addition, research was done to determine the current status of technology and engineering programs in elementary schools in the City of Chesapeake, nationally, and internationally.

One survey was created for teachers and administrators. The survey was administered online to those willing to participate. Information regarding interest in implementing technology and engineering programs fostering engineering design skills was collected. A letter was distributed to parents requesting participation in the survey. Upon completion of the surveys and interviews, data were recorded, compiled, and analyzed. Results were documented and reported.

## Definition of Terms

The following terms are used in this study.

**Educational or Instructional Technology:** The use of technology to change the way learning and teaching takes place to make it more meaningful and impactful for educators and learners around the globe (ISTE, 2016).

**Engineering Design Process:** The process involved in creating a new product or process in an educational or business setting. It is flexible, cyclical, and has five basic steps: ask (define problem and constraints), imagine (brainstorm ideas), plan (draw a diagram and list materials), create (follow plan, create, and test), and improve (modify design and test) (EIE, 2016).

**Enrichment**: Any extra programming that is provided to students outside the core subjects of mathematics, science, social studies, and English. This includes, but is not limited to, music, art, physical education, computer lab, media center/library, technology, and foreign languages.

**Technology**: The branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment, drawing upon such objects as industrial arts, engineering, applied science, and pure science. (Technology, n.d.)

**Technology and Engineering Education**: The area of study that includes the human-designed world. It also focuses on achieving technological literacy and providing a foundation for technical education (OCTE, 2016).

**Technological Literacy:** The ability to use, manage, assess, and understand technology. A technologically literate person understands what technology is, how it is created, how it shapes society, and is shaped by society (ITEEA, 2007).

## Overview and Summary

Technological literacy has become an essential requirement for employers today in the global marketplace. It is critical to streamline processes using technological tools to improve efficiency and profits. Future employees must be properly prepared for and comfortable working in dynamic environments where new technological advances are introduced everyday. Not only do people need to know how to use technology, but how to analyze a problem and find a feasible solution when something goes wrong. This problem solving mindset is a learned skill necessary for all citizens (National Academy of Engineering and Nation Research Council, 2002).

Technology and engineering education in our schools needs to be improved to incorporate more problem solving scenarios related to technology. It is not enough to just teach a student how to use a computer and where to find things on the internet. Children need to learn how to use raw materials to make something, how to test their ideas, and fix their mistakes to succeed. This type of education requires facilitated independent thought and group collaboration between students and teachers.

The purpose of this study was to determine the feasibility of adding technology and engineering education in the elementary schools in the City of Chesapeake. The goal of the technology and engineering program is to increase technological literacy in elementary school students. To develop the evidence proving its feasibility, research was completed to define the current standards and curriculum related to technology and engineering education in the state and the nation. Surveys were distributed to administrators and teachers at elementary schools. The results of this study will be valuable in determining the desire and need for additional technology and engineering education.

Chapter II of this study contains a review of literature that examines studies related to technology curriculums, engineering problem solving, and technological literacy in elementary schools. It also defines the existing standards related to technology and engineering education in the State of Virginia's Standards of Learning (SOLs) and Technology and engineering education program.

Chapter III outlines the methods and procedures used in this study. Detailed objectives are defined for the surveys and interviews. The process used for analyzing the survey and interview results is also described.

Chapter IV presents the findings for the study. This information was compiled from the literature review as well as from the survey and interview results.

Chapter V provides conclusions derived from the surveys and literature. The feasibility of incorporating technology and engineering education into elementary schools is described. In addition, obstacles are defined that may prevent implementation of a technology and engineering education program. Future research areas are also suggested to continue the process of improving technology and engineering education in our schools.

# CHAPTER II
# REVIEW OF LITERATURE

In order to illustrate the current need for technology and engineering curriculum in our primary schools, it is necessary to understand how technology and engineering education has evolved over the last half century and its role in society today. The first topic discussed is how technology and engineering education differs from technical education and instructional technology. This differentiation is important to ensure proper curriculum development. Second is defining technological literacy and how to create a classroom environment that fosters innovative learning. The next literature review investigates the current technology and engineering educational initiatives that exist within the State of Virginia and the City of Chesapeake. It is important to understand the vision that each level of government has for this initiative. The last topic investigates what technology standards exist at the State and City levels serving as the foundation for curriculum development.

## Technical Education versus Technology and Engineering Education

Technical education deals with specific skills and technical proficiencies, whereas technology and engineering education deals with a global knowledge of technology and its role in society (Frazier, 2009). The foundation for technology and engineering education (Hershbach, 2009) was laid through the industrial arts movement of the mid-20$^{th}$ century. Industrial arts was a subject that was available to all students in order to provide them with knowledge and skills that would be beneficial in any career field. Industrial arts focused on giving students the ability to learn by doing while allowing them to perform practical skills in completing projects (Barlow, 1967).

The Carl Perkins Act, originally authorized in 1984 as the Carl D. Perkins Vocational Education Act of 1984, was one of the most significant pieces of legislation that has fostered the growth of technology and engineering education. This legislation had several key provisions, which included assisting the states to expand, improve, modernize, and develop quality vocational education programs to meet the needs of the nation's existing and future workforce. Another key provision consisted of assuring that all individuals were given access to quality vocational education programs such as those that were for disadvantaged, handicapped, entering non-traditional occupations, and those with limited English proficiency (Paulter, 1999). This act also promoted technological literacy through technology and engineering education. One of the purposes of the Perkins Act was to prepare a workforce with the academic and vocational skills needed to compete successfully in a world market (DoE, 2002).

The Act was reauthorized in 1998 and most recently in 2006 as the Carl D. Perkins Career and Technical Education Improvement Act of 2006. The most recent revisions include support for partnerships with secondary schools, postsecondary institutions, baccalaureate degree granting institutions, and career technical centers. There was also a push to the newest version of the Perkins Act to develop research and best practices to improve the quality of Career and Technical Education. Educational definitions have been updated and new terms such as "Career and Technical Education", "career pathways", and "articulation agreement" have been implemented (ACTE, 2005).

Technology and engineering education is an area of study within career and technical education that is designed to integrate the academic core subjects by providing students with practical hands-on applications of the content through technological activities. Although technology and engineering education courses are typically listed as electives, they serve a vital role in implementing a curriculum that blends technical concepts and academic principles. As students start to understand various technical concepts they acquire new skills and insights, and they begin to see the value that technology and engineering education has in relation to their educational aspirations and career goals. Students get a true sense of how the competencies that they are learning in class can be applied to real-world situations. A significant amount of the content that is learned in technology and engineering education courses contains many of the same principles that students are learning in their academic subjects (Frazier, 2009).

However, there is a lack of understanding in America about how to define technology and engineering education. Stereotypes exist regarding technology and engineering education, including that it is an ethnocentric and sexist curriculum and prepares the next generation assembly line worker (and should be avoided by those who have greater aspirations). These issues lead to several other obstacles that diminish the role technology and engineering education could play in educating to innovate (Macho, 2010). Students need to have the opportunity to experience technology innovation themselves to determine what technology and engineering education entails.

Technology and engineering education provides a contextual basis for reinforcing the content of the core areas (Berry & Ritz, 2004). If the skills to be transferred can be identified and the context can be established where learners see that the skills they had learned could be applied to solve problems in other contexts (situations), then student success should improve (Bjork & Richardson-Klavhen, 1989). The goal of the STEM initiative was to integrate science, technology, engineering, and mathematics into a curriculum that helps students to become higher academic achievers and more technologically literate (Frazier, 2009).

## Technological Literacy

With the evolution of the technology and engineering education movement from vocational education, the former American Industrial Arts Association changed its name to the International Technology Education Association and led the development of standards to guide the study of technology. This standard movement was inspired by the need for a more technologically-skilled workforce that could produce innovation (ITEA, 1996). The standards movement defined technological literacy as the ability to use, manage, and understand technology. The content for study was then described as the universals of technology with the processes of designing and developing, determining and controlling the behavior of, utilizing, and assessing the impact and consequences of technological systems; knowledge of the nature and evolution of technology, linkages, and technological concepts and principles; and context as information, physical, and biological systems (ITEA, 2002).

Technological literacy is when a student has a general understanding of technology and how it relates to the world around them (National Academies of Sciences, 2008). To be technologically literate a person must have an understanding of the nature and history of technology, a basic hands-on capability related to technology, and the ability to think critically about technological development (National Academy of

Engineering and National Research Council, 2002). Technological literacy is not the same as technical competence. Some individuals (e.g., plumbers, automobile mechanics, computer programmers, airplane pilots) may be very competent in the use of one or more specific technologies but may not be technologically literate (Ollis & Pearson, 2006). Technological literacy is critically important for the general population, not just for STEM-oriented persons (O'Brien, 2010). A technology and engineering literate person is someone who can use the engineering design process to solve a problem by designing a product or system that works while taking into consideration many factors such as safety, environmental impacts, risks, and benefits (ITEA, 2002).

Creating a classroom environment where students are able to experience hands-on learning about technology requires careful planning and facilitated instruction by trained professionals. Regardless of who is claiming what in STEM education, there is one seminal component that is captured in either STEM education or technology and engineering education. This component is the purposeful combination of engineering design, scientific inquiry, and mathematical computation in the context of real-life problem solving (Wells, 2013). A problem-based learning environment that purposefully applies mathematics, scientific inquiry, and engineering design in the context of an authentic problem can help mimic the way in which STEM professionals act in the workplace outside of school settings (Sanders, 2009).

Johnson and Thomas (1994) supported these ideas by stating that an effective technology and engineering education program is one that increases students' procedural and declarative knowledge by providing them with opportunities to develop technological skills that can be transferred to a variety of contexts through practicing solving relevant engineering design problems. Hmelo-Silver (2004) described problem-based learning as a situated learning environment in which students must complete real-world relevant tasks that they have not previously experienced as a means to emphasize a meaningful, experiential learning experience. Problem-based learning also incorporates levels of learner meta-cognition by requiring students to reflect upon their experiences in designing a solution to a problem (Jonhson, 1992). Roberts (2013) highlighted that technology and engineering fundamentals provide opportunities for students to be educated in creative problem solving techniques needed for the jobs of the future.

Neomillennial students are no longer satisfied with obtaining all their information from textbooks or instructors; rather, these "digital students learn in classrooms where the technology is a seamless component of learning that expands the educational environment beyond the classroom walls and beyond the existing capabilities of learners" (Smaldino, Lowther, & Russell, 2008, pg. 335). The technology classroom environment must motivate and inspire students to find solutions to real world problems. Smaldino, Lowther, and Russell (2008) define a learning environment as the "learning setting," comprising "physical surroundings in which learning is expected to take place; " this can include "the classroom . . . the laboratory (computer lab, science lab, or language lab), library, media center, playground, field trip site, theatre, study hall, and at home" (p. 16).

Martinez (2010) promoted the idea that students should develop knowledge in real-life environments, thus gaining more transferrable higher-order cognitive skills. Mimicking real-world experiences in the classroom can help account for unanticipated challenges that students may face in their future, especially in engineering careers, because knowledge is deeply embedded in the experiences or situations in which it is learned (Brown, Collins, & Duguid, 1989). Higher-order cognitive skills can enable citizens to function in a complex society by increasing their ability to make meaningful decisions to solve the world's multifaceted problems (Martinez, 2010). Consequently, many educational stakeholders have modified their curriculum and instructional strategies as well as their assessment practices to reflect more authentic student experiences and to emphasize complex cognition through problem-solving activities (Bjorklund, 2008; Liao, 2011; Zoller, 2011).

The environment should be developed around the needs of the school, the subject and content to be taught, and specific goals and objectives (Hefzalla, 2004; Kelly, 2008; Price, 2007). Schools need to become empowered to design and develop such learning environments. The flexibility of technology provides a learning environment in which students can select the tools most appropriate to their needs and comfortable to their learning styles (Kelly, 2008). Ultimately, learning environments are much different than they were 25 years ago. The increased emphasis on collaboration, student responsibility for learning, communication, access to higher levels of information, and critical thinking has permanently changed the traditional learning environment (Niess, Lee, & Kajder, 2008).

## Technology and Engineering Educational Initiatives

The STEM crisis has been created by the troubling signs that have been brought to light because of how far the United States lags behind other countries in the ranks of

STEM education, abilities, and careers (The President's Council of Advisors on Science and Technology, 2011). When compared to other nations, the mathematics and science achievement of U.S. pupils and the rate of STEM degree attainment appear inconsistent with a nation considered the world leader in scientific innovation. In the early 21st century, international reports were showing there were only less than one-third of eight graders in the United States that scored at a proficient level in mathematics and science (Kuenzi, 2008). Technology and engineering education now has a stance that the superiority of a country as a leader in technology is a desired quality, as well as the ability of an educational system to produce individuals possessing technological abilities (de la Paz & Cluff, 2009).

The National Science Foundation, in hopes of improving student scores in mathematics and science, funded project UPDATE in 1991. Throughout the country enrollment in "shop" class, or "industrial arts" class, was down. The truth was that enrollment in those traditional "Industrial Arts" classes had been down for years; that trend has been reversed mainly due to the change in curriculum. The time for a change came, and many schools changed the name of the class to Technology Education, but they did not change very much of the curriculum, and they did not teach the teachers how to change or how to teach this new subject. The result was more confusion in the technology education profession (James, 2002). R. Todd, author of Chapter 7 in the 46th Council on Teacher Technology Education yearbook on Elementary School Technology Education, believes that a paradigm shift in the mindset of educators and administrators is what is needed in order to fix the public school system. That new paradigm was the

Design and Technology (D&T) approach where concepts and theory emerge from practice (Todd, 1997).

In order to achieve this paradigm shift, it was necessary to understand and document the cognitive processes which technological innovation aids in achieving. To understand cognitive operations involved specifically with technological problems, Halfin (1973) analyzed the work of prominent technological problem solvers. Through his analysis he identified 17 mental processes used by professional technologists to solve a technological problem. These cognitive operations are defining problems, observing, analyzing, visualizing, computing, communicating, measuring, predicting, questioning, interpreting, constructing models, experimenting, testing, designing, modeling, creating, and managing. Additionally, Lawson (2005) noted that creating solutions to these problems involves highly complex and sophisticated cognitive skills that must be learned and practiced to enable a successful engineer or designer to perform them unconsciously.

Starkweather (1997) stated concerning technology and engineering education: we must focus on the end result, which is quality thinking. We must combine thinking with doing in a style that produces the next generation of technological problem solvers. Each country depends upon its educators to develop thinkers that will progress their civilization. The key to progress is fundamental in one way; “How can we best design learning that will result in creative, functional, and open-ended technological thinkers” (Starkweather, 1997, pg 5-6). When technology educators are able to do that, we will be thinking to achieve!

The state of Virginia has been proactive in establishing a vision for how technological literacy is taught in schools. The Office of Technology and Virtual Learning at the Virginia Department of Education published the *Educational Technology Plan for Virginia: 2010-15* and the *2015-2017 Addendum* in 2015. This document outlines the strategic direction for implementing both educational technology and technology and engineering education planning throughout the State. The vision for the Virginia Board of Education is to prepare all students to be capable, responsible, and self-reliant citizens in the global society. To that end, the Department of Education will integrate innovative and authentic technologies effectively throughout all facets of the educational system to improve student academic achievement and 21st century skills and knowledge (OTVL, 2015).

Some recent technology initiatives that the State of Virginia has funded are the following:

1. In 2005, Virginia created a network of more than 1,200 instructional technology resource teachers (ITRT) to help teachers integrate technology into the classroom effectively. With this action, Virginia became the first state in the nation to provide instructional technology support to teachers on this scale. At the same time, the Commonwealth added technology support personnel to ensure the effective operation and maintenance of the technology and supporting infrastructure (OTVL, 2015).

2. Since 2008, the ***Learning without Boundaries*** initiative has helped the Commonwealth understand the technical, social, and policy implications of integrating wireless handheld devices into schools.

3. In 2010, the ***Beyond Textbooks*** project studied the potential impact of tablets in education. The first pilot involved iPads used in various grade levels and

subject areas.

4. In 2013, the ***e-Learning Backpack Initiative*** was implemented in various schools; it was designed to provide Virginia's struggling students with tablets to enable personalized learning.

5. In 2014, Virginia formed a partnership with Copia to develop an online ***Digital Textbook Marketplace,*** the first of its kind in the nation. EducationSuperHighway, a national nonprofit, worked with Virginia schools to find ways to increase bandwidth availability throughout the state. (OTVL, 2015)

Virginia defines Information and Communication Technologies (ICT) literacy as a synergistic blend of cognitive, technical, and social skills that enable students to use technology responsibly (safely and ethically) and effectively to advance learning and develop strong thinking habits in all subject areas. This blend should lead each student toward a lifelong ability to communicate; solve problems; and access, manage, integrate, evaluate, and create information. The goals, objectives, and methods of the Educational Technology plan incorporate the best thinking about ICT literacy and cognitive science. The goal is to create a flexible framework that allows individual schools and divisions to implement systemic changes that support 21st century learning and greater academic achievement. Just as this plan builds upon national standards, division plans should not only align with the statewide framework but also define specific objectives based upon local-needs assessments (OTVL, 2015).

The State instructed school divisions to utilize the appropriate strategies and measures addressed in the statewide goals and objectives while, at the same time, leveraging their unique strengths. Beyond the goals and objectives of the state's plan, division technology committees may create effective plans by adding goals and objectives that support division missions and visions. Division technology plans need to follow good planning procedures, reflect state and local goals, and be useful to all stakeholders. With an increased emphasis on supportive data collection, divisions also must collect appropriate and useful information during the evaluation phase of the planning cycle (OTVL, 2015). The state also created the Essential Elements of ICT Literacy. This document defines what students, parents/guardians, teachers, school administrators, and school boards need to know about ICT literacy. This resource provides a framework for all stakeholders in the education process of children to follow to ensure ICT literacy is achieved.

There are several challenges that exist related to preparing students for the future. The first challenge is related to how quickly technology changes. The half-life of technology often is measured in weeks rather than years and when the stream of new information grows exponentially. Twenty-first century learning is often suggested as the answer to this challenge; however, twenty-first century learning, and the technology that supports it, is a broad concept—actually, much too broad—requiring us to rethink every aspect of our education system (OTVL, 2015). The second challenge is the gap between students and access to technology-based resources, also know as the *digital divide*. Technology generates new levels of inequality among students outside of school; those from a higher-income family or with a higher achievement level have more opportunities to interact with technology than students from lower economic status (Brown-L'Bahy, 2005; Davis, Fuller, Jackson, Pittman, & Sweet, 2007). Placing students in technologically rich learning environments fosters additional use of such tools and helps level the playing field (Schroeder & Zarinnia, 2007).

The third challenge is that some educators have misinterpreted the concept of integrating technology as merely using e-mail to communicate with parents, developing a class Web page, maintaining grades electronically, or using PowerPoint in a classroom presentation. While these tasks are important, they neither constitute technology integration nor student engagement (Smith, Bichelmeyer, Monson, & Horvitz, 2008). True engagement requires students and teachers to apply appropriate technology to learning situations. It requires technology that can be personalized and adapted to individual students and that provides interactive and collaborative experiences. This shift in roles requires continual professional development to keep teachers up-to-date and adequately prepared. Maggie Niess, John Lee, and Sara Kajder (2008) argue that continual learning and preparation are the "keys for assuring educational reform that adequately prepares students to meet the challenges of the twenty-first century" (p. xiv). As such, teachers "must consistently engage in learning about new and emerging technologies . . . how to teach both *about* and *with* the new and emerging technologies" (p. xiv, italics original). The message is that teachers can no longer teach in the manner they were taught; they must remain as flexible and dynamic as the technology itself (Mehlinger & Powers, 2002).

Chesapeake Public Schools (CPS) published their own *Division Technology Plan Update and Addendum* in 2015. It is the goal of Chesapeake Public Schools to ensure that provided technology is used optimally to enhance the learning of students and to provide a more efficient and effective operation of the school system. This document focuses on instructional technology and not technology and engineering education. As stated in the document, technology use is widespread throughout the elementary and secondary curricula. The elementary school philosophy emphasizes the importance of a curriculum that promotes strong basic skills in the most technology enriched environment possible. Emphasis is placed on communication skills (reading, writing, speaking), math, science, social studies, the arts, physical education, and technology. Secondary schools focus their emphasis on real-world experiences tied to the use of technology in addition to supporting the curricula. Every effort is made to maximize instructional time by integrating technology into the curricula (CPS, 2015).

CPS students use technology at every grade level as a tool to enhance the curriculum and support the Standards of Learning. To promote this integration, Chesapeake has made a significant effort to provide the appropriate and necessary technology on an equitable basis across the school system. CPS strives to provide a learning environment that offers alternate learning opportunities in addition to traditional environments, all of which will incorporate the use of effective technology. To accomplish this goal, the school division aims to equip its faculty and staff with the ability to recognize and utilize technologies to engage students in contextual learning. The appropriate selection of technology tool, training, and the improved communication between staff, students and parents allows CPS to focus on a holistic learning approach (CPS, 2015).

Chesapeake Public Schools has implemented several software tools in their programs.  These include interactive whiteboards, an elaborate technical infrastructure, virtual instruction programs (VIP), video-conferencing equipment, a bring your own device program, an electronic grade book for teachers, an automated parental alert system, and geospatial information system (GIS) data utilization. The vision described in the City of Chesapeake Technology Plan is based on having technology resources and not to integrate technology to create true engagement and apply technology in learning.

The City performed an assessment of their technology programs as directed per the State Technology Plan. They sought to find out what type of technology is used, how it is used, and to determine if the school division was optimizing the use of technology. The answers to these questions laid the groundwork for establishing future uses of technology that will benefit the school division. The action team developed the five-part mission statement and subsequent guiding principles reflecting the technology needs of students, teachers, and administrators for Chesapeake Public Schools. Using the mission statement as a foundation, the action team formulated fifty recommendations. These initiatives provide an ongoing implementation framework that the City evaluates annually to monitor status and completion. The goals, objectives, and local strategies and methods of the Virginia Educational Technology plan are also included in the Chesapeake Technology Plan.

There is a gap that exists between the State and City plans. The State defines educational technology requirements in addition to technology and engineering educational requirements. The City includes the educational technology requirements in their plan, but does not address technology and engineering educational requirements in their plan.

## Technology Standards

Aside from governmental agencies and organizations wanting all students to be technologically literate, there has been a push in the American education system to establish and adhere to academic standards. According to Gronlund (1993), the purpose of establishing the goals is twofold: first, to increase the achievement level of all students and second, to provide equal opportunity education for all students. Although most states have a given set of standards that their students must cover in core academic areas such as mathematics and science, there were numerous inconsistencies from state to state as to which standards were emphasized. STEM content standards and the sequence in which content was taught varied greatly among school systems, as did the expectations for and indicators of success (National Science Board, 2007). The International Technology Education Association (ITEA) was an organization committed to supporting technology and engineering education teachers by providing them with instructional materials and keeping them abreast of trends in the field of technology and engineering education. The ITEA viewed its mission as promoting technological literacy for all by supporting the teaching of technology and promoting the professionalism of those engaged in these pursuits (ITEA, 1995).

In 2000, *Standards for Technological Literacy* were published by the ITEA with support from the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA). These standards presented a vision of what students should know and be able to do in order to be technologically literate. The standards described what the content of technology and engineering education should be for grades

K-12 (ITEA, 2002). These standards described what technological literacy content should be studied in the elementary, middle, and high school grades. The individual standards presented in *Standards for Technological Literacy* were organized into five major categories, each of which was addressed in its own chapter. These major categories, around which the standards were developed, were the nature of technology, technology and society, design, abilities for a technological world, and the designed world (Dugger, 2001). The *Standards for Technological Literacy* have become the backbone for school systems and educational entities to design curriculum in order to deliver a current and up-to-date technology and engineering education program (Frazier, 2009).

In 2002, the International Technology and Engineering Educators Association's Center to Advance the Teaching of Technology and Science (ITEEA-CATTS) developed the only standards-based national model for grades K-12 that delivers technological literacy (ITEA, 2002). The model is called Engineering by Design, and it was built on *Standards for Technological Literacy* (ITEA), *Principles and Standards for School Mathematics* (NCTM, 2004), and *Project 2061 Benchmarks for Science Literacy* (AAAS, 2008). According to the ITEA (2002), students participating in the program learn concepts and principles in an authentic, problem-based environment. Some of the goals of the program were to ensure that all students were technologically literate, restore America's status as the leader in innovation, and increase student achievement in mathematics, science, and technology. To emphasize the importance of engineering as a key part of technological literacy, ITEA changed their name in 2010 to the International Technology and Engineering Education Association (ITEEA).

In 2016, ITEEA's Center for Teaching and Learning published the Integrative-STEM (I-STEM) FocalPoints initiative. This initiative views STEM content through a single lens to provide a truly integrative STEM education. It is a framework that connects the STEM Dots through each of the content areas (Science, Technology and Engineering, and Mathematics) and provides a model for future Pre-K – 12 curriculum development as well as a guide for schools that wish to pursue a STEM emphasis. The initiative is based upon the *Standards for Technological Literacy*, *Next Generation Science Standards, Common Core State Standards,* and the National Academy of Engineering's *Engineering Habits of Mind*. The strategic plan includes integrating the FocalPoints into the Engineering by Design model. The FocalPoints are the basis for the development of Integrative STEM Education activities and provides a measure by which to assess the activity. Implementing this Integrative STEM Education program provides direction for teachers, administrators, and parents about what they should see in an integrative STEM classroom. It also provides clear guidance for curriculum developers to incorporate into existing programs (ITEEA STEM CTL, 2016).

Another program that supported some of these initiatives and at the forefront of changing the structure of school curricula and promoting the implementation of STEM ideologies was Project Lead the Way (PLTW). Project Lead the Way is a nonprofit organization that provides transformative learning experiences for K-12 students and teachers across the U.S. Their mission is to help students learn problem-solving strategies, critical and creative thinking, and how to communicate and collaborate through pathways in computer science, engineering, and biomedical science (PLTW, 2014).

This organization had designed several different programs where school systems could immediately implement pre-existing curricula for their students. Each curriculum provides an activity-, project-, and problem-based curriculum, that gives students in kindergarten through high school a chance to apply what they know, identify problems, find unique solutions, and lead their own learning. The elementary program was called *PLTW Launch* and enables elementary students to use structured approaches, like the engineering design process, and employ critical thinking. By applying STEM knowledge, skills, and habits of mind, students learn that it is OK to take risks and make mistakes. The middle school program was called *PLTW Gateway* and provides engineering, biomedical, and computer science curriculum for middle school students that challenges, inspires, and offers schools variety and flexibility. Students get rigorous and relevant experiences through activity-, project-, and problem-based learning (PLTW, 2014).

There are three different high school programs. *PLTW Engineering* is about applying engineering, science, mathematics, and technology to solve complex, open-ended problems in a real-world context. Students focus on the process of defining and solving a problem, not on getting the "right" answer. They learn how to apply STEM knowledge, skills, and habits of mind to make the world a better place through innovation. *PLTW Biomedical Science* explores a range of careers in biomedical sciences as students learn content in the context of real-world, hands-on activities, projects, and problems. The last program is *PLTW Computer Science*, which inspires students to consider the endless possibilities in careers that use computing (PLTW, 2014).

The Curry School of Education at the University of Virginia has developed the Children's Engineering Initiative. The goal of this initiative is to change how STEM disciplines are approached in the nation's elementary classrooms and how teachers are prepared and supported to facilitate student learning and development. The concept of digital fabrication is utilized in this initiative. This is a project-based learning approach that maps to skills in mathematics, science, technology, and engineering, all in a project based team setting. By integrating digital fabrication into the curriculum and elementary learning setting, this initiative enables a fundamental transformation that fosters more advanced and innovated performance among young people in the STEM disciplines. The Children's Engineering Initiative includes the following four components: hardware, software, and online digital fabrication library and collaborative space, and a curriculum. The goal is that teachers will introduce engineering and mathematics to elementary school students in an engaging context, which will result in a positive impact on the students (Bull, 2015).

Engineering is Elementary is another curricula available to support elementary educators with developing engineering literacy. The curriculum products use the field of engineering as a unifying theme. The units stand alone and can be used in any order. The lessons are flexible and may be adapted for different grade levels and abilities. The activities use simple and inexpensive materials, and appeal to all types of students. The goal of the program includes the four views of learning: contextual learning and problem solving, collaborative learning and teamwork, communication, and project-based learning. The curriculum design challenges help students draw connections with the world around them (context). The activities encourage collaborative thinking in a group setting and consider multiple solutions to one problem (collaborate and teamwork). By sharing ideas through speaking, writing, drawing, and building students develop communication skills. Lastly, as students analyze information and make decisions about their design, they engage with the curriculum and take ownership of their learning (EiE, 2016).

There are specific standards for Technology and Engineering Education in the State of Virginia written in the form of competencies. But there are no specific standards for technology and engineering education at the elementary school level. There are Computer Technology Standards that were created in February 2013. These standards define the essential knowledge and skills necessary for students to access, manage, evaluate, use and create information responsibility using technology and digital resources. They provide a framework for digital literacy and include the progressive development of technical knowledge and skills, intellectual skills for thinking about and using information, and skills needed for working responsible and productively both individually and with groups. It focuses on using technology to learn rather than learning about technology across all K-12 content areas (BoE VA, 2013).

Additional technology standards are incorporated in the History and Social Science Standards of Learning and the Science Standards of Learning (BoE VA, 2010). Not all of ITEEA's Standards for Technological Literacy are incorporated into the Computer Technology, History and Social Science, and Science Standards of Learning. There are no specific standards defined for primary education in the City of Chesapeake that relate to learning how to apply technology to learn and innovate, just how to find information using technology.

## Overview and Summary

Technology and engineering education continues to evolve as technology changes in our world. National, state, and professional organizations are taking the initiative to create a pathway to follow in our educational system to ensure that students are prepared to serve in our global workforce after completion of schooling in this technological age. The Virginia Department of Education has created a Technology Plan that instills technological literacy at all age levels and creates a new type of classroom that requires adaptable technology that provides interactive and collaborative experiences. The independent school districts are responsible for implementing these concepts in their programs. The City of Chesapeake has made significant strides in the implementation of a technological infrastructure to support this type of learning and communication between stakeholders, but the methods of instruction have not changed. Professional organizations, including ITEEA and PLTW have created technological literacy curriculum programs that school systems can implement to help teachers learn how to make this transition to collaborative learning in this technological age.

Chapter III explains the methods and procedures used for this research study. The chapter identifies and describes the population used to collect data, the type of instrument used to collect data, the procedures used during data collection, the analysis of data, and the validity and reliability of the data.

# CHAPTER III
# METHODS AND PROCEDURES

The purpose of this study was to determine the feasibility in offering technology and engineering programs in elementary school in a southeastern Virginia school district to increase technological literacy among younger students. A literature review provided the background on federal, state, and local technology initiatives that exist for public schools. It also defined technology standards that exist and how they have been incorporated in state curriculum requirements at the elementary level. Random samples of teachers and administrators were surveyed to determine the current satisfaction of the technology and engineering education program and reactions to new technology program initiatives. The data was collected and analyzed using measures of central tendency including mean and mode. The variability of the collected data was also analyzed to determine any correlations that existed in the data. Open question items were compiled and analyzed to determine the opinions of the individuals in the sample.

## Population

The population for this research study was elementary school teachers and administrators in the City of Chesapeake, Virginia. There are twenty-eight elementary schools within seven high school districts in the City of Chesapeake (CPS, 2013). By including all schools in the population the data encompasses all cultural, socio-economic, and racial diversity that exists in the school district.

## Instrument Design

One data collection instrument was used for this research project: an online survey was created for teachers and administrators (see Appendix A). The survey consisted of closed Likert scale questions and a few questions with the option for comments and feedback. At each elementary school in the sample teachers and administrators received email notification of the online survey and a request for participation. The purpose of the survey was to determine the level of satisfaction with the current technology programming, the level of familiarity with technological literacy, and feedback related to adding new technology and engineering education programming.

## Methods of Data Collection

Data was collected using an online survey. A cover letter was also provided to all participants in the sample. The letter provided background information about the purpose of the research study, risks involved, and who authorized the survey. The survey was selected as the data collection instrument to ensure validity and consistency of the data. The reliability of the data was demonstrated by sampling teachers and administrators throughout the same school district. The same curriculum is taught at the schools. Some of the schools do receive additional funding for programming because of Title 1 status. The external validity of the research is based upon a population of schools with lower, mid, and higher socioeconomic levels. This research was reviewed and approved as an exempt study by the College of Education's Human Subjects Review Committee at Old Dominion University.

## Statistical Analysis

The data collected was analyzed in multiple ways. The first was to analyze each school's data using the mean and mode measures of central tendency. These statistical elements provide a baseline for comparison purposes. They indicate the average response given to each question and also the most popular answer. By comparing the means it is possible to see if extraneous factors affected the results. The survey information was compiled and also analyzed to determine any patterns in the collected data.

## Summary

The methods and procedures for this research study include collecting data from teachers and administrators through a random survey in elementary schools in one school district in southeastern Virginia. The collected data was analyzed by comparing response means and mode. The research findings are explained in the next chapter. The data results are explained by question and across the participant schools. The results are then analyzed to determine if correlations exist in the data.

# CHAPTER IV
# FINDINGS

The purpose of this study was to determine the feasibility of implementing technology and engineering design programming into the elementary school curriculum in the surveyed school district. This information can be used by the school system to determine what schools are currently doing to teach technology and engineering design in their programs and gauge the current level of staff satisfaction with the current technology educational programming. The study also provides administrators with staff feedback as to preferred methods of implementation of technology and engineering education curriculum. The data retrieved through this study were analyzed to meet the research objectives:

$RQ_1$. Do elementary teachers and administrators believe technology and engineering programming provides new educational opportunities for students?

$RQ_2$. What is the reaction to technology and engineering programming as an educational option among elementary teachers and school administrators?

$RQ_3$. What obstacles exist for implementation of a technology and engineering program?

This chapter contains the collected and analyzed data to satisfy these objectives. Response rate, survey responses, statistical analyses, and a summary of findings were presented.

## Response Rate

The study sought a response from eight hundred fifty teachers and administrators at the elementary schools in the selected school district to participate in a survey to collect information related to technology and engineering education programming feasibility.  The survey response rate was 9% (N=77) by study participants.

## Survey Responses

There were 10 questions to gather information on the study's three research questions.  The demographic data is presented first followed by the data for each research question.

The first two questions of the survey provided demographic information about the respondents.  The first question asked individuals to identify their job title at the elementary school.  There are only two options: teacher or administrator.  All teachers, teacher assistants, and support personnel are classified as teachers.  Principals and vice principals are categorized as administrator.  Survey respondents included 92.2% (n=71) teachers and 7.8% (n=6) administrators as defined in Table 1.

**Table 1** ***Job Classification***

| **Respondents** | **Response Percent** | **Response Count (n)** |
|---|---|---|
| Teacher | 92.2% | 71 |
| Administrator | 7.8% | 6 |

The second question asked respondents to identify the school where they are employed.  The participating school district requested that all school names remain anonymous in the results.  Schools are identified with an alphabetic identifier.  All of the schools, except three had at least one respondent complete the survey.  As illustrated in Table 2 the schools with  5 or more respondents were School K at 14.29% (n=11), School U at 9.09% (n=7), School G at 7.79% (n=6), and School X at 6.49% (n=5).

**Research Question 1: Does technology and engineering programming provide new educational opportunities for students?**

Survey questions 4, 6 and 7 addressed this research question. Questions 4 used a Likert scale for participants to identify their level of agreement with the question with 1 representing strongly agree, 2 representing agree, 3 representing neutral, 4 representing disagree, and 5 representing strongly disagree. Questions 6 and 7 used closed form yes and no responses.

**Table 2** ***Respondents by Elementary School***

| School Identifier | Response Percent | Response Count (n) |
|---|---|---|
| A | 0.0% | 0 |
| B | 5.2% | 4 |
| C | 2.6% | 2 |
| D | 1.3% | 1 |
| E | 1.3% | 1 |
| F | 5.2% | 4 |
| G | 7.8% | 6 |
| H | 5.2% | 4 |
| I | 2.6% | 2 |
| J | 1.3% | 1 |
| K | 14.3% | 11 |
| L | 3.9% | 3 |
| M | 3.9% | 3 |
| N | 3.9% | 3 |
| O | 1.3% | 1 |
| P | 5.2% | 4 |
| Q | 1.3% | 1 |
| R | 0.0% | 0 |
| S | 3.9% | 3 |
| T | 1.3% | 1 |
| U | 9.1% | 7 |
| V | 0.0% | 0 |
| W | 1.3% | 1 |
| X | 6.5% | 5 |
| Y | 5.2% | 4 |
| Z | 1.3% | 1 |
| AA | 5.2% | 4 |
| BB | 0.0% | 0 |

Survey question 4 asked if the school system provides opportunities for elementary school students to use different types of technology, learn about different types of technology and how and when to use them, troubleshoot and find solutions to problems using technology and the engineering design process, and understand technology through facilitated problem based projects. For the first part of this question about using different types of technology, survey responses found that 12.9% (n=10) strongly agreed, 50.65% (n=39) agreed, 10.39% (n=8) were neutral, 23.38% (n=18) disagreed, and 2.6% (n=2) strongly disagreed. For the second part of this question about learning about different types of technology and how and when to use them 5.19% (n=4) strongly agreed, 38.96% (n=30) agreed, 12.99% (n=10) were neutral, 40.26% (n=31) disagreed, and 2.60% (n=2) strongly disagreed. For the third part of the question related to troubleshooting and finding solutions to problems using technology and the engineering design process 2.6% (n=2) strongly agreed, 14.29% (n=11) agreed, 24.68% (n=19) were neutral, 45.45% (n=35) disagreed, and 12.99% (n=10) strongly disagreed. The last part of this question related to understanding technology through facilitated problem based projects 3.9% (n=3) strongly agreed, 10.39% (n=8) agreed, 25.97% (n=20) were neutral, 49.35% (n=38) disagreed, and 10.39% (n=8) strongly disagreed. Table 3 depicts this information.

**Table 3** ***Chesapeake public school's technology opportunities for elementary students***

| Answer Options | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Use different types of technology | **12.99%**<br>10 | **50.65%**<br>39 | **10.39%**<br>8 | **23.38%**<br>18 | **2.6%**<br>2 |
| Learn about different types of technology and how and when to use them | **5.19%**<br>4 | **38.96%**<br>30 | **12.99%**<br>10 | **40.26%**<br>31 | **2.6%**<br>2 |
| Troubleshoot and find solutions to problems using technology and the engineering design process | **2.6%**<br>2 | **14.29%**<br>11 | **24.68%**<br>19 | **45.45%**<br>35 | **12.99%**<br>10 |
| Understand technology through facilitated problem based projects | **3.9%**<br>3 | **10.39%**<br>8 | **25.97%**<br>20 | **49.35%**<br>38 | **10.39%**<br>8 |

Survey question 6 asked if their school offers technology or engineering clubs or after school programs (e.g. Destination ImagiNation, First Lego League, Odyssey of the Mind, etc.). Eighteen percent (n=14) said yes and 81.58% (n=62) said no as illustrated in Table 4. The fourteen yes responses came from schools B (n=1), E (n=1), F (n=1), H (n=3), I (n=2), L (n=2), M (n=1), O (n=1), Q (n=1), and AA (n=1). This question also had an open form comment field for respondents answering yes. Twelve of the 14 respondents provided further information about the specific programs offered at their school. They include the following: Robotics Club (n=6), Lego League (n=4), Science and Technology Club-5$^{th}$ grade only (n=1), and Destination Imagination (n=1).

**Table 4** ***Technology and Engineering Clubs or After School Programs Present***

| Answer Options | Response Percent | Response Count |
|---|---|---|
| Yes | 18.4% | 14 |
| No | 81.6% | 62 |
| If Yes, what program? | | 12 |
| Robotics Club | | 6 |
| Lego League | | 4 |
| Science and Technology Club | | 1 |
| Destination Imagination | | 1 |
| Skipped question | | 1 |

Survey question 7 asked if “implementation of a technology and engineering design program would provide new education opportunities at my school”. Ninety-two percent (n=70) answered yes, and 7.89% (n=6) responded no as depicted in Table 5. The respondents who answered ‘no’ were from different schools, School K (n=1), School N (n=1), School S (n=1), School T (n=1), and School AA (n=2).

**Table 5** ***Technology and Engineering Design Program Provides New Opportunities***

| Answer Options | Response Percent | Response Count |
|---|---|---|
| Yes | 92.1% | 70 |
| No | 7.9% | 6 |
| Skipped question | | 1 |

**Research Question 2: What is the reaction to technology and engineering programming as an educational option among teachers and school administrators?**

Questions 3, 5, and 9 addressed research question two. Questions 3 used a Likert scale for participants to identify their level of agreement with the question with 1 representing strongly agree, 2 representing agree, 3 representing neutral, 4 representing disagree, and 5 representing strongly disagree. Question 5 used a Likert scale also, with 1 representing extremely, 2 representing satisfied, 3 representing neutral, 4 representing dissatisfied, and 5 representing extremely dissatisfied. Question 9 was a closed form format with five multiple choice options (including other) and a comment field to explain if other option was selected.

Question 3 asked if technology and engineering design (defined as the study of the human designed world) is essential to learn about in school. As illustrated in Table 6, thirty-four percent (n=26) strongly agreed, 52.63% (n=40) agreed, 6.58% (n=5) were neutral, 3.95% (n=3) disagreed, and 2.63% (n=2) strongly disagreed. One participant skipped this question.

**Table 6 Importance *of Technology and Engineering Design in School***

| Answer Options | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| | **34.21%**<br>26 | **52.63%**<br>40 | **6.58%**<br>5 | **3.95%**<br>3 | **2.63%**<br>2 |

Question 5 requested the current level of satisfaction with the opportunities that exist at each school to teach technology and engineering skills. Three percent (n=2) were extremely satisfied, 22.37% (n=17) were satisfied, 31.58% (n=24) were neutral, 38.16% (n=29) were dissatisfied, and 5.26% (n=4) were extremely dissatisfied. The respondents that were satisfied or extremely satisfied with the current opportunities were from eleven different schools: School B (n=3), School C (n=2), School H (n=1), School K (n=6), School L (n=1), School N (n=1), School Q (n=2), School T (n=1), School U (n=1), School X (n=1), and School Z (n=1). The four respondents that were extremely dissatisfied were from three different schools: School I (n=2), School P (N=1), and School U (n=1).

**Table 7 *Satisfaction Level with Current Technology and Engineering Opportunities at Schools***

| Answer Options | Extremely satisfied | Satisfied | Neutral | Dissatisfied | Extremely dissatisfied |
|---|---|---|---|---|---|
| | **2.63%**<br>2 | **22.37%**<br>17 | **31.58%**<br>24 | **38.16%**<br>29 | **5.26%**<br>4 |
| NOTE: One respondent skipped the question | | | | | |

Question 9 requested respondents to select a preference for technology and engineering design education implementation. The choices provided were the following: integrated into general classroom facilitated by regular teacher, taught as weekly enrichment program in technology classroom facilitated by certified technology teacher, taught in technology classroom facilitated by regular teacher and volunteers with pre-defined grade level appropriate activities, after school in a technology classroom facilitated by volunteer teacher, and other (please specify). Twelve percent (n=9) selected integrated into general classroom facilitated by regular teacher. Seventy-six percent (n=58) selected taught as weekly enrichment program in technology classroom facilitated by certified technology teacher. Seven percent (n=5) selected taught in technology classroom facilitated by regular teacher and volunteers with pre-defined grade level appropriate activities. Four percent (n=3) selected after school in a technology classroom facilitated by volunteer teacher. One percent (n=1) selected other and entered in the comment field "regular resource class taught by Tech Specialist assigned to our building".

**Table 8** ***Preference for Technology and Engineering Design Education Implementation***

| Answer Options | Response Percent | Response Count |
|---|---|---|
| Integrated into general classroom facilitated by regular teacher | 11.8% | 9 |
| Taught as weekly enrichment program in technology classroom facilitated by certified technology teacher | 76.3% | 58 |
| Taught in technology classroom facilitated by regular teacher and volunteers with pre-defined grade level appropriate activates | 6.6% | 5 |
| After school in a technology classroom facilitated by volunteer teacher | 3.9% | 3 |
| Other (please specify) | 1.3% | 1 |
| Skipped question | | 1 |

### Research Question 3: What obstacles exist for implementation of a technology and engineering program?

Questions 8 and 10 address this research question. Question 8 is yes and no question with an optional open comment field. Question 10 was a closed form format with five multiple choice options (including other) and a comment field to explain if the other option was selected. Question 8 was included to define if any existing teachers at the elementary school level were members of any professional technology or engineering educational organizations. One respondent answered yes and stated they had National Board Certification. Ninety-nine percent (n=76) answered no. Question 10 asked respondents for the biggest obstacle for implementation of a technology and engineering curriculum in the city school district. Sixty-five percent (n=49) indicated a lack of funding, 3.95% (n=3) picked lack of curriculum, 3.95% (n=3) selected lack of professional development, 14.47% (n=11) chose lack of materials, and 13.16% (n=10) elected other and entered a comment. The comments entered included the following:

- Lack of funds
- Lack of materials/funds (especially at our middle class school) and pacing guide/not enough time to integrate
- Lack of time (n=3),
- Depending on what school a teacher works in the pressure to pass state tests overwhelms and eliminates a teacher's ability and desire to implement technology and engineering effectively. These unfortunate circumstances can be directly attributed to the state of Virginia's lack of concern for how their testing regime affects teachers and students.
- Not enough working laptops in the classroom –not enough open slots in the computer lab to provide consistent time on computers.
- All of the above (n=2)
- At the primary school level, we do not have time in our day to add yet another component to our curriculum. We have enough on our plates with teaching basic skills related to reading, comprehension, writing, and computation. It's not that I am opposed to technology because I certainly believe that our children should be ready to adapt to the technologically-advanced world we live in. I just think it belongs in the upper grades possible.

**Table 9** ***Biggest Implementation Obstacle***

| **Answer Options** | **Response Percent** | **Response Count** |
|---|---|---|
| Lack of Funding | 64.5% | 49 |
| Lack of Curriculum | 3.9% | 3 |
| Lack of Professional Development | 3.9% | 3 |
| Lack of Materials | 14.5% | 11 |
| Other (please specify) | 13.2% | 10 |
| Skipped question | | 1 |

## Analysis

Table 10 illustrates the statistical data for each question in the research survey. Question 2 and 8 were left out of the table because they had no statistical significance and were used for grouping of data and information purposes. The lower the numerical value assigned to each choice, the greater the respondent agreed with the statement. The question type, mean, median, mode, and standard deviation are defined. For question 9 the following values were assigned to each choice option: integrated into general classroom facilitated by regular teacher (1), taught as weekly enrichment program in technology classroom facilitated by certified technology teacher (2), taught in technology classroom facilitated by regular teacher and volunteers with pre-defined grade level appropriate activities (3), after school in a technology classroom facilitated by volunteer teacher (4), and other (5). For question 10 the following values were assigned to each choice option: lack of funding (1), lack of curriculum (2), lack of professional development (3), lack of materials (4), and other (5).

Questions 4, 6, and 7 are used to answer the first research question if technology and engineering design provide new educational opportunities to students. Based on the data for question 4, sixty-four percent (M=2.51) of staff agree that the schools currently use different types of technology in the classroom. Staff is evenly split on if the current programs include learning about different types of technology and how and when to use them (M=2.96). Eighty-three percent of respondents were neutral or disagreed that the current program provides opportunities for students to troubleshoot and find solutions to problems using technology and the engineering design process (M=3.53). Sixty-seven percent of survey participants were neutral or disagreed that the current program provides opportunities for students to understand technology through facilitated problem based projects (M=3.53). The data for question 6 indicates that eighty percent of respondents do not have a technology, engineering club, or related after school program at their school. The respondents who indicated a program exists at their school were from ten different schools in the school district. That represents 36% of the elementary programs in the school district. Question 7 indicates that 92% of respondents agree that implementation of a technology and engineering design education program would provide new educational opportunities at their schools.

**Table 10** ***Statistical Research Data***

| Question # | Format | Mean | Median | Mode | SD |
|---|---|---|---|---|---|
| 1 | Teacher (1)<br>Admin (2) | 1.08 | 1.00 | 1.00 | 0.27 |
| 3 | Likert | 1.88 | 2.00 | 2.00 | 0.88 |
| 4a | Likert | 2.51 | 2.00 | 2.00 | 1.06 |
| 4b | Likert | 2.96 | 3.00 | 4.00 | 1.04 |
| 4c | Likert | 3.53 | 4.00 | 4.00 | 0.97 |
| 4d | Likert | 3.53 | 4.00 | 4.00 | 0.94 |
| 5 | Likert | 3.23 | 3.00 | 4.00 | 0.95 |
| 6 | Yes (1)<br>No (2) | 1.82 | 2.00 | 2.00 | 0.39 |
| 7 | Yes (1)<br>No (2) | 1.08 | 1.00 | 1.00 | 0.27 |
| 9 | Multiple Choice | 2.06 | 2.00 | 2.00 | 0.67 |
| 10 | Multiple Choice | 2.06 | 1.00 | 1.00 | 1.56 |

Questions 3, 5, and 9 addressed the reaction to technology and engineering programming as an educational option among teachers and school administrators. Question 3 demonstrates that 87% of respondents (M=1.88) agree that technology and engineering design is essential to learn about in school. Question 5 portrays that 44% of respondents (M=3.23) were not satisfied with the current opportunities that exist at their school to teach technology and engineering skills, compared to 25% that were satisfied. Question 9 provided insight into the staff's ideas for effective implementation of a technology and engineering design program. Seventy-seven percent of respondents felt that this programming should be taught as a weekly enrichment program in a technology classroom facilitated by a certified technology teacher. The second most popular response with a 12% response rate was integrated into the general classroom facilitated by the regular teacher.

Question 10 provides insight into what staff felt was the biggest obstacle for implementation of a technology and engineering curriculum in the school district. Sixty-five percent of respondents selected lack of funding. Another 14% selected lack of materials.

## Summary

Data was collected from 77 out of 850 (approximately 9%) teachers and administrators in elementary schools in a designated school district in southeastern Virginia. Twenty-four out of twenty-eight schools (85%) were represented in the survey. Ninety-two percent of respondents agree that implementation of a technology and engineering design education program would provide new educational opportunities at their schools. In regards to current programming at schools the data collected indicated that 87% of respondents agreed that technology and engineering design is essential to learn about in school. Sixty-four percent (64%) of staff agreed that the schools currently use different types of technology in the classroom. Respondents were evenly split on if the current programs include learning about different types of technology and how and when to use them. Eighty-three percent (83%) of respondents felt that the current program does not provide opportunities for students to troubleshoot and find solutions to problems using technology and the engineering design process. Sixty-seven percent (67%) of participants indicated that the current program does not provide opportunities for students to understand technology through facilitated problem based projects. Only 20% of respondents indicated that they have a technology, engineering club, or related after school program at their school. Forty-four percent of respondents were not satisfied with the current opportunities that exist at their school to teach technology and engineering skills. Sixty-five percent of participants felt that lack of funding was the biggest obstacle faced by the school district for implementation of a technology and engineering design program. Lastly, 75% of staff felt the most effective way for curriculum implementation is through a weekly enrichment program in a technology classroom facilitated by a certified technology teacher.

## CHAPTER V
## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### Summary

The purpose of this research study was to determine the feasibility in offering technology and engineering design educational programs in the elementary schools in Chesapeake, Virginia. The three research questions for this study were designed to investigate whether teachers and administrators think technology and engineering education provide new opportunities for elementary students, how they felt about technology and engineering education, and what obstacles exist for successful implementation.

This study had a limited sample, but demonstrates the need for adding a technology and engineering curriculum in elementary schools. Both administrators and teachers agreed that implementation of a technology and engineering curriculum would provide new opportunities to elementary school students. Teachers and administrators indicated that the current curriculum does *not* give ample opportunities for students to troubleshoot and find solutions to problems using technology and the engineering design process, and understand technology through facilitated problem based projects.

By introducing technology and engineering education in elementary schools, students are given the opportunity to learn about technology and the engineering design process through inquiry based problem solving activities. Students gain exposure to a new way of thinking and begin to learn how to quickly adapt to changing technologies, assess current technology and processes for problems and deficiencies, and have the ability to innovate new solutions to current problems. If elementary students received instruction in technology and engineering they would be more equipped to make informed decisions about what elective path they would enjoy in middle and secondary school.

## Conclusions

Ninety-two percent of respondents agreed that implementation of a technology and engineering design education program would provide new educational opportunities at their schools. Eighty-seven percent of respondents also felt it is essential for students to learn about technology and engineering design in elementary school.

The elementary schools should consider improving opportunities for students to use technology and the engineering design process to troubleshoot and find solutions to problems through facilitated projects. In addition, opportunities to understand technology through facilitated problem based projects should be considered. Only a quarter of respondents were satisfied with the current technology and engineering educational opportunities at their schools.

The biggest obstacles that exists for successful implementation of a technology and engineering educational curriculum is lack of funding, followed by a lack of materials. Over three quarters of the teachers and administrators who participated in the survey indicated they preferred implementation through a weekly enrichment program facilitated by a certified technology teacher.

## Recommendations

The public schools need to further evaluate the most effective means of implementing a technology and engineering education program in the elementary schools. Teachers and administrators in the study preferred a weekly or bi-weekly class similar to the current enrichment programming format used for physical education, art, music, media center/library, and computer lab.

Over ninety percent of the respondents were teachers. Increasing the response of administrators for future research should be emphasized. Further research investigating the same research questions with curriculum coordinators at the city level would provide additional insight about the feasibility of implementing a technology and engineering education program. Including parents in the population would provide insight into the expectations that parents have in an elementary technology and engineering program.

The online survey was an effective data collection instrument by automating the data analysis process. In future research adding a personal interview with an administrator from each school would be valuable. This establishes a relationship with each administrator. This in return enables a more in-depth analysis of their opinions related to the research topic and facilitates the distribution of the survey by having them disseminate it to staff.

The survey should not be distributed at the end of the school year. The response rate for this study was extremely low at 9%. This time of year can be very busy and stressful for teachers, resulting in teachers ignoring the email and there not being enough time to send out a second reminder email to the participants. In the future, using a school administrator to send out the research participation request may increase response rates.

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APPENDIX A – SURVEY

## Technology and Engineering Design Education Survey

Please answer the following questions.

1. What is your job title?

2. At what elementary school do you work?

3. Technology and engineering design (defined as the study of the human designed world) is essential to learn about in school.

| Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

4. Chesapeake public schools provide opportunities for elementary students to do the following:

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Use different types of technology | ○ | ○ | ○ | ○ | ○ |
| Learn about different types of technology and how and when to use them | ○ | ○ | ○ | ○ | ○ |
| Troubleshoot and find solutions to problems using technology and | ○ | ○ | ○ | ○ | ○ |

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| the engineering design process | | | | | |
| Understand technology through facilitated problem based projects | ◯ | ◯ | ◯ | ◯ | ◯ |

5. Current level of satisfaction with the opportunities that exist at your schools to teach technology and engineering skills.

| Extremely satisfied | Satisfied | Neutral | Dissatisfied | Extremely dissatisfied |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

6. Does your school offer technology or engineering clubs or after school programs (e.g. Destination ImagiNation, First Lego Leauge, Odyssey of the Mind, etc.)?

◯ Yes

◯ No

If Yes, what program?

7. Implementation of a technology and engineering design education program would provide new educational opportunities at my school.

◯ Yes

◯ No

8. Are you a member of any professional technology or engineering educational organization (e.g. VA Children's Engineering Council (VCEC), VA Technology and Engineering Education Association (VTEEA), etc.)?

- ◯ Yes
- ◯ No

If Yes, which one?

[ ]

9. Select a preference for technology and engineering design education implementation.

- ◯ Integrated into general classroom facilitated by regular teacher
- ◯ Taught as weekly enrichment program in technology classroom facilitated by certified technology teacher
- ◯ Taught in technology classroom facilitated by regular teacher and volunteers with pre-defined grade level appropriate activites
- ◯ After school in a technology classroom facilitated by volunteer teacher
- ◯ Other (please specify)

[ ]

10. What is the biggest obstacle for implementation of a technology and engineering curriculum in the City of Chesapeake?

- ◯ Lack of Funding
- ◯ Lack of Curriculum
- ◯ Lack of Professional Development
- ◯ Lack of Materials
- ◯ Other (please specify)

[ ]

APPENDIX B – CITY OF CHESAPEAKE APPROVAL LETTER

**Chesapeake Public Schools**
School Administration Building
312 Cedar Road
Chesapeake, Virginia 23322

May 19, 2016

Dear Natalie Emery:

Your request to conduct research regarding **the feasibility of offering technology and engineering design literacy programs in elementary school** for Old Dominion University is approved. The approval is granted with the understanding that the following conditions will apply:

- Participation of administrators and/or teachers is strictly voluntary.
- Parent permission must be obtained for student participation (if applicable).
- Names of individuals, school names or the name of the school division cannot be used in the reporting of the results of your findings without prior permission from the Department of Staff Development (Research Approval), Chesapeake Public Schools.
- All copies, distribution, retrieval of materials and arrangement of interviews/collections will be your responsibility.
- Questions/procedures must be limited to those detailed in your prospectus.

You may use this letter as a cover letter when contacting administrators. Should you have further questions, please feel free to contact me at 757-547-0914.

Sincerely,

Dalphine A. Joppy, Ed.D.
Director of Staff Development
(Research Approval)

*The Chesapeake Public School System is an equal educational opportunity school system. The School Board of the City of Chesapeake also adheres to the principles of equal opportunity in employment and, therefore, prohibits discrimination in terms and conditions of employment on the basis of race, sex, national origin, color, religion, age, or disability.*

APPENDIX C – OLD DOMINION UNIVERSITY IRB EXEMPTION LETTER

OLD DOMINION UNIVERSITY

OFFICE OF THE VICE PRESIDENT FOR RESEARCH

**Physical Address**
4111 Monarch Way, Suite 203
Norfolk, Virginia 23508
**Mailing Address**
Office of Research
1 Old Dominion University
Norfolk, Virginia 23529
Phone(757) 683-3460
Fax(757) 683-5902

| | |
|---|---|
| DATE: | June 2, 2016 |
| TO: | Philip Reed |
| FROM: | Old Dominion University Education Human Subjects Review Committee |
| PROJECT TITLE: | [912804-1] Technological Literacy in Elementary School |
| REFERENCE #: | |
| SUBMISSION TYPE: | New Project |
| ACTION: | DETERMINATION OF EXEMPT STATUS |
| DECISION DATE: | June 2, 2016 |
| REVIEW CATEGORY: | Exemption category # *[6.2]* |

Thank you for your submission of New Project materials for this project. The Old Dominion University Education Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Petros Katsioloudis at (757) 683-5323 or pkatsiol@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Education Human Subjects Review Committee's records.

- 1 -

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APPENDIX D – COVER LETTER

OLD DOMINION UNIVERSITY

STEM Education and Professional Studies
228 Education Building
Norfolk, Virginia 23529-0498
Phone (757) 683-4305
Fax (757) 683-5227

Office of the Chair
Fashion Merchandising
Industrial Technology
Instructional Design and Technology
Marketing Education
Mathematics Education
Occupational and Technical Studies
Science Education
Technology Education
Training Specialist
Military Career Transition Program in Technology

May 20, 2016

Dear Teachers and Administrators,

Your participation is requested to fill out an online survey on technology and engineering design literacy programs in elementary schools. This study is conducted through Old Dominion University's STEM Education and Professional Studies department by Natalie Emery, a Master's student. The purpose of the study is to determine the feasibility of offering technology and engineering design literacy programs in elementary school in the City of Chesapeake.

Technology and engineering design education focuses on the study of the human designed world and how people modify the natural world to meet their needs. Children today learn how to use technology on a daily basis, but learning how to manage, assess, and understand technology requires facilitated problem based instruction to help students discover how technology works and the design process to create new technologies. Teachers use instructional technologies including: computers, whiteboards, and personal handheld devices to facilitate the learning process, but in the state of Virginia there currently is no defined technology education or engineering curriculum at the elementary school level.

This survey is voluntary and your responses are anonymous. You may withdraw your participation at any time. There is no compensation given for completion of this survey. Participant identities will be protected because the only identifiers are the elementary school name in which you work. The data collected will be kept on a password protected computer and results will be reported in aggregate. Your opinions are important for determining the interest in implementation of technology and engineering design in our public schools. If you have any questions about this study please contact Natalie directly at nemer001@odu.edu.

Sincerely,

Philip A. Reed, Graduate Program Director
Occupational & Technical Studies

Natalie S. Emery, Graduate Student