ASSESSING ELEMENTARY PUPILS' ATTITUDES TOWARD TECHNOLOGY

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ABSTRACT

Making all US citizens technologically literate necessitates investigation into how to achieve this literacy. The *Standards for Technological Literacy: Content for the Study of Technology* (STL) is intentional about ensuring technological literacy in all students. Instilling this knowledge in elementary students is an emerging field that requires assessment tools that conveys understanding into what student attitudes are about technology and technological concepts. Developing appropriate technology education curriculum that promotes meaningful and integrative learning hinges on a comprehensive and clear understanding of these attitudes.

Originally designed for middle school age students, the PATT (Pupils' Attitudes toward Technology) instrument was developed and administered in the Netherlands. In 1988 the PATT-USA instrument, translated from Dutch to English, was given to 10,000 US middle and high school students and was validated for assessing their attitudes toward technology. Due to the age of the instrument, dated technological terminology was updated with language reflective of today utilizing inter-rater analysis. The purpose of this descriptive research examines the viability of using the modified PATT, now the PATT-ELEM, instrument with elementary students in the assessment of their attitude toward technology.

DEDICATION

"Never give up until you reach the finish line" was the fortune cookie message I received on my very first step of this journey. This long journey has included many who have inspired me along the way. I dedicate this dissertation to my family: Bob, Leslie, Mom, Dad, and Benjamin. You have encouraged to carry on and have never left my side on the journey. I also dedicate this work to friends: Linda Harpine and Challenge teachers who have supported me throughout this process and have cheered me on. Dr. John G. Wells, my advisor, I am so grateful for your guidance and nurturing throughout this process. I also want to thank other members of my doctoral committee, Dr. Thomas O. Williams Jr, Dr. Kelly Parkes, and Dr. Jeremy Ernst, for their reassuring words and much appreciated assistance along the way. All of you have my deepest appreciation.

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CHAPTER 1:

INTRODUCTION

Nature of the Problem

In the context of the current United States (US) STEM (Science, Technology, Engineering, and Mathematics) education reform, the past decade has demonstrated a growing emphasis on incorporating technological/engineering (T/E) design in elementary education. This reform is driven by a projected shortfall of 2.4 million STEM professionals in the near future, which only can be remedied through strategic STEM education practices (Scott & Martin, 2012).

The importance of assimilating T/E design in the elementary grades is emphasized by the fact that young students are receptive to this rich learning context and may yield higher achievement scores among STEM subjects. There is evidence that the technological design-based approach is beneficial to students' cognitive abilities and achievement (Brusic, 1991; Korwin, 1986; Saunders & Shepherdson, 1984). According to Sanders (2008), "Elementary grades offer unique opportunities for integrative approaches to STEM education and are absolutely the place to begin these integrative approaches. If America hopes to effectively address the 'STEM pipeline' problem, we must find ways of developing young learners' interest in STEM education and must sustain that interest throughout their remaining school years" (p. 22). The elementary classroom is the most flexible environment in which to apply integrative STEM approaches that include T/E design, unlike the secondary level where standardized testing, collaboration among teachers, and lack of instructional materials are challenges that prohibit this schema.

For several years the United States education system has been grappling with the fact that students are scientifically and technologically illiterate (ITEA, 1996, 2000). Boser, Palmer, and

Daugherty (1998) discussed misconceptions among citizens include the relationship of science and technology as well as the definition of technology. Therefore, because of these misconceptions, society is failing to equip American students with the technological knowledge to compete in our global society. Interestingly enough, Bybee (2000) asserted that “for a society so deeply dependent on technology, we are largely ignorant about technological concepts and processes, and we mostly ignore this discrepancy in our educational system” (p. 27). Thus, in order to change this current reality, the United States needs to concentrate on correcting these misconceptions as well as improving our delivery of the science and technology experience.

Specifically, the publication *Technically Speaking: Why All Americans Need to Know More About Technology* (2006), operationally defined technological literacy in terms of three dimensions "knowledge, capabilities, and ways of thinking and acting" (Pearson & Young, 2002, p. 15). People who are technologically literate understand what technology is, how it is created, and how it shapes and is shaped by society (Dugger, 2001). All citizens must acquire knowledge and skills in order to contribute to the 21st century workforce and this must be addressed by our nation’s educational system (Friedman, 2005).

In 2000, the International Technology Education Association (ITEA) purported that technological literacy is "the ability to use, manage, assess, and understand technology" (p. 9). The ITEA (1996) *Technology for All Americans Project* stated that the main goal for the field of technology education is to promote technological literacy. The *Standards for Technological Literacy: Content for the Study of Technology* (STL) (ITEA/ITEEA, 2000, 2002, 2006) were developed and challenged educators, specifically those in the field of technology education, to structure curriculum that support students in becoming technologically literate. These standards were intended to provide an essential core of technological knowledge and skills for all grades in

American schools. The PK-12 goals of the STL are both strategic and deliberate in their promotion of technological literacy in providing the structure for what every students need to know and do.

In 2010, it was projected that a substantial shortfall of science, technology, engineering, and math (STEM) professionals would require an increased number of undergraduate STEM degrees by about 34% in order to meet the demand at the current rate (President's Council of Advisors on Science and Technology [PCAST], 2010). Given the pressing needs for a quality STEM workforce in the 21st century, this STEM movement has come to the forefront of public education but the development of technologically literate students begins in the elementary classroom. Children who experience STEM education early on will be equipped to understand, increasingly more sophisticated STEM concepts later in their academic careers. Augustine (1998), referring to a National Science Foundation survey conveying that Americans were clearly lacking in technological literacy, emphasized the need to raise awareness of this lack of knowledge. He was optimistic when he explained that if educators become more adept at explaining science and technology, while at the same time encouraging more rocket science for beginners, that the future would be bright.

The current assessment driven culture tends to limit elementary curricula in providing opportunities for developing student problem solving abilities and associated higher order thinking skills. These skills are at the core of what STEM education and technological literacy intends to address. Specifically, traditional curricula are focused more on assessing declarative and/or procedural knowledge rather than the capacity for higher order thinking which are necessary for problem solving. The propensity of the elementary student to engage in technological activity, curiosity, and lack of inhibition creates an optimum opportunity for development of higher order thinking and problem solving abilities. Teachers involved in a study by Koch and Burghardt (2002) agreed with consensus that multi-disciplinary T/E experiences promoted higher-level thinking, conversation, and problem solving by children. Engaging students in T/E design has been shown to not only promote problem solving abilities, but also development of the technological literacy all citizens need in order to participate and be productive in a technological society. Furthermore, developing both problem solving and technological literacy needs to begin early in PK-12 education.

In the US there are a number of national initiatives promoting T/E design at the elementary level with the goal of improving students' problem solving abilities. At the national level, there are initiatives such as Engineering is Elementary developed by the Museum of Science, Boston (Museum of Science, 2015). The International Technology and Engineering Education Association's (ITEEA) Engineering by Design curriculum is a standards-based national model for Grades K-12 that delivers technological literacy in a STEM context. PK-12 initiatives that target the elementary level are seen in programs such as Children's Engineering (Virginia Children's Engineering Council, 2015) that teaches children to use creative and critical thinking skills while applying classroom learning undergirding attainment of learning standards. As well, there are examples of elementary schools that have fully embraced T/E design school-wide resulting in documented gains in school-wide science scores over the past three years (Virginia Department of Education, School Report Card, 2014). John Wayland Elementary School in Bridgewater, Virginia is one such example. By and large evaluation of these initiatives is generally aimed at assessing gains in science and mathematics content knowledge. However, not being assessed as an outcome of T/E design at the elementary level is the degree to which students are developing technological literacy or their attitudes toward their technological world. According to Pearson and Young (2002) the unfortunate truth is that we really know very little about what children know, can do, and believe about technology.

With the mentioned initiatives in place a focus on how well these efforts are at achieving technological literacy is moving forward. The National Academy of Engineering and the National Research Council called the Committee on Assessing Technological Literacy spent over two years examining the status and prospects for assessment of technological literacy. Their report, *Tech Tally: Approaches to Assessing Technological Literacy*, recommended five areas of concentration for the future. Among them were instrument development, computer-based assessment methods, and perceptions of technology (Pearson & Young, 2002). Not having a widely accepted standardized instrument for assessing the broader construct of technological literacy is the issue, particularly at the elementary level.

Within the broad scope of technology education measuring technological literacy as practiced has led some educators to select measures in the affective domain as an alternative way to assess technological literacy (Bame, Dugger, de Vries, & McBee, 1993; Raat & de Vries, 1986). Conducting attitudinal research gives insight in how attitudes influence behavior and how each entity of the integrated affect/cognition/behavior system influences student learning. McLoughlin and Young (2005) concluded that evaluation from these types of assessments provides feedback loops that are critical to the ongoing design of better educational programs. Moreover, Bain and LaBoy-Rush (2010) reported that engagement in elementary technology education programs inspired continuous involvement as well as built self-esteem for learning in later years.

Assessment of student attitudes toward technology has been done previously at the middle and high school levels specifically using the internationally recognized *Pupils' Attitudes*

Toward Technology (PATT) instrument. Boser, Palmer and Daugherty (1998) initiated research using the PATT-USA, as a standardized attitude measure, to see if it would provide insight into effective teaching approaches to positively affect students' attitude toward technology because there were no accepted or standardized cognitive measures of technological literacy. Supported by research from the affective domain, Boser et al., (1998) postulated that students who have a positive experience in a technology education program will possess a positive attitude toward technology and that a positive attitude toward technology would lead to interest in studying about technology and interest in pursuing technological careers. Subsequently, technologically literacy would be attained.

Students will experience a lifetime of technological change and adaptation and with the implementation of T/E design-based education within the elementary curriculum these students can succeed at achieving technological literacy. If we are to know technological literacy is developing among elementary students we must create a protocol for assessing it. Lacking are tools and resources for assessing the development of technological literacy at the elementary level. Attitudinal changes toward technology are linked to obtaining technological literacy. New evidence provides that if students have a positive tendency toward school subject then they will have more interest in it (Krathwohl et al., 1964). The PATT-USA model, used for middle and high school students, should be able to measure that attitude change at the elementary level.

Rationale for the Study

The Committee on Highly Successful Schools or Programs for K-12 STEM Education (National Research Council, 2011) reports that strategies, such as funding, teacher professional development, and adequate instructional time and resources are suggested and encouraged by all schools in their attainment of STEM goals. This will help promote the "T" in STEM. As STEM education is vital to our nation's continued growth, leadership, and development, this report documented some important shortcomings that could hinder our progress as well. Given the growing trend toward incorporating T/E design-based teaching in elementary education and the lack of available instrumentation for assessing the level of technological literacy resulting from this approach to teaching and learning, the need exists for creating and validating such instrumentation. The National Science Foundation reports that discipline-based K-12 education research in science and engineering has continually advanced in the past ten years and is projected to continue that way (Moore & Smith, 2014). Furthermore, support for the need of such instrumentation is growing and providing evidence to substantiate that the relationship between attitudes and attaining technological literacy is strengthened when attitudes toward technology are found favorable.

In a broader sense, in making the case for raising the level of technological literacy it must be shown that the effect of technology education and T/E design instruction is fostering positive attitudinal change. Moore and Smith (2014) affirmed that to make progress for K-12 STEM integration advancement that emphasis on engineering design must be included in the curriculum as well as students seeing the interconnectedness of subjects. In the report, *Tech Tally: Approaches to Assessing Technological Literacy* (National Academy of Engineering and National Research Council, 2006), it was stressed that until technological literacy was assessed in a rigorous, systematic way, "It is not likely to be considered a priority by policy makers, educators, or average citizens" (p. 22).

Nationally, as the K-5 grade levels moves towards the STL and the T/E design-based strategies that exposes students to more technology or engineering based curriculum, schools will need to measure and understand program success as well as student achievement. Currently, schools assess student achievement in the traditional academic disciplines such as math and reading; that data alone will be insufficient in the future. As we progress as a technological society determination of the effectiveness of instruction and of student learning will require assessment of student knowledge and understanding of technology.

Purpose of the Study

As has been indicated the STEM education movement seeks to address the problems of technological and scientific literacy among all students in the United States. Lacking are widely accepted standardized instruments suitable for assessing elementary students' attitudes toward technology. The intent of this study was to develop an instrument that assesses elementary students' attitudes toward technology. Research assessing such attitudes among students in upper grade levels, middle and high school, has been conducted in the past using the PATT instrument. As there are drastic differences at many levels between elementary and secondary students, the original PATT instrument might not be appropriate or adequate in assessing the technology attitudes of elementary level students. It can however serve as the template for creating an instrument tailored to the elementary school level. The specific purpose of this study is to modify sufficiently the PATT instrument for administration at the elementary level and to determine its viability for assessing attitudes toward technology among elementary level students.

Research Questions

The following research questions (RQs) and sub-questions (Sub-Qs) direct this study:

RQ1. To what extent is a modified PATT Instrument (PATT-ELEM) a valid tool to assess fifth grade students' attitudes toward technology?

Sub-Q1: What level of content validity can be established in measuring fifth grade attitudes toward technology?

Sub-Q2: What level of construct validity can be established in measuring fifth grade attitudes toward technology?

Sub-Q3: How suitable is the readability level of the PATT-ELEM instrument for fifth grade students?

Sub-Q4: What level of reliability can be established in measuring fifth grade attitudes toward technology?

RQ2. What are fifth grade students' attitudes toward technology?

Limitations of the Study

Participants selected for this research may will only be those who have previously experienced some level of technology education/children's engineering instruction during their tenure at the participating elementary school, and with reading level abilities sufficient for completing the survey.

Delimitations of the Study

Field-testing of this instrument was limited to only those fifth grade participants from the one elementary school selected for this research study.

Definition of Key Terms in the Study

Attitude

In social psychology, attitude is an enduring and general evaluation or cognitive schema relating to an object, person, group, issue, or concept. Strength and valence can vary, thus, an attitude can be negative or positive. This can also refer to any subjective belief or evaluation associated with an object (n.d.). Retrieved March 14, 2015, from http://psychologydictionary.org/attitude/

Elementary School Technology Education (ESTE)

> ”ESTE is any educational program in which children engage in design and problem solving, and constructional/manipulative activities to help them learn about themselves and the technological world around them (Kirkwood & Foster, 1997, p. 3).

Pupils' Attitude towards Technology (PATT) Instrument

> Instrument developed to seek out students' attitudes toward technology and their understanding of technological concepts. (Bame, E., Dugger, W., Jr., de Vries, M., & McBee, J., 1993, p. 40)

Technology Education (TE)

> “A school subject specifically designed to help students develop technological literacy” (ITEA/ITEEA, 2000, 2002, 2006, p. 142).

Technological Literacy (TL)

> “The ability to use, manage, assess, and understand technology” (ITEA/ITEEA, 2000, 2002, 2006, p.9)

CHAPTER 2:

LITERATURE REVIEW

In laying the groundwork for development of the research design, a review of the relevant literature to support the research questions posed and to broaden understanding of the topics presented within this study was conducted. This review is organized into four main components: Theoretical Framework, Technological Literacy in the Elementary Classroom, and Attitudes and Elementary Student's Technological Literacy.

Theoretical Framework

Deweyism in Technology Education

Froebel (1889), the initiator of kindergarten early in the 19th century, believed in the importance of fostering children's growth and development through using many three-dimensional materials. His ideals embraced how reception and reflection produced understanding and how, when the student was engaged in self-activity, he was able to apply what was perceived. Froebel also believed that manual training was essential for all students even if the student did not intend to have a career in industrial employment.

Froebel's inspiration championed John Dewey (Dewey & Dewey, 1915) idea of *learning by doing*. Dewey (1916) and his European predecessors made compelling arguments for the importance of hands-on skills and inductive learning processes in child development. He stated the importance of education being a natural development in which children attain certain knowledge at appropriate levels. In the early 20th century during the progressive movement, Dewey (1916) fostered the constructivist pedagogy, a theory of cognitive growth and learning.

Dewey's *learning by doing* theory involved adding content to context in creating an emotional experience that led to meaningful learning. This philosophy, along with the works of

Piaget (1929) and Lewin (1936) emphasized the philosophy of experiential education, which is the process of making meaning from direct experience. This had a profound influence on IA programs, especially at the elementary level.

Building on Dewey's theory of experience of life as a self-renewing process and the idea of constructivism, Bonser and Mossman (1923) developed and advanced the "social-industrial theory" of IA. Their text, *Elementary School Industrial Arts*, posited that the purpose of IA was to provide instruction in industrial and technological subject matters at all levels to all students. They defined IA as "a study of the changes made by man in the forms of materials to increase their value, and of the problems of life related to these changes" (p. 5). Bonser had experienced the ruggedness of the frontier life, traveling in a covered wagon. It was said that he displayed his father's sturdy pioneering and problem-solving attitude toward life's problems (Foster, 1995). Mossman, a teacher, saw the benefits of aligning the school's practical work with traditional curriculum.

The collaborative efforts of Bonser and Mossman stressed the importance of mental stimulation and problem solving centered on the principle of design. Students who designed original ideas had ownership and self-expression. Problem solving strategies were naturally integrated and student practiced this investigative process, which brought satisfaction and ownership. The text stated it this way: "Satisfaction comes from both the activity itself and the achievement in making some kind of product, crude as it may be" (Bonser & Mossman, 1923, p. 35). Thus, the process, not the product, is substantive, and along with it are developed positive problem-solving attitudes toward designing through that learning by doing process.

Behaviorism vs. Constructivism in Elementary Technology Education

Two theories of learning relevant to attitudinal research are behaviorism and constructivism. A behaviorist looks at the content to be learned and the influence of the environment upon that learning. A constructivist would be more interested in knowing how the learner is attempting to construct meaning. Whereas a behaviorist would continue to look at the content to be learned and the influence of the environment upon that learning, a constructivist would be more interested in knowing how the learner is attempting to construct meaning.

A behaviorist states that behavior could be predicted and controlled (Skinner, 1974). Behaviorists also believed that "only observable, measurable, outward behavior is worthy of scientific inquiry" (Bush, 2006, p. 14). Skinner (1958) and Watson (1925), behaviorist theorist, advocate that learning is affected by changes in the environment. In terms of assessment, the behaviorist view states that learning occurs by accumulating atomized bits of knowledge, and learning is tightly sequenced and hierarchical, transfer is limited, so each objective must be explicitly taught. Tests are used frequently to ensure mastery before proceeding to the next objective and motivation is external and based on positive reinforcement of many small steps (Shepard, 2000)**.**

Dewey and other progressives from his era believed that the schools were separated and isolated from society, putting children in learning situations that were not reflective of real life or dealt with problems of society (Zuga, 1997). Dewey's social reconstruction ideas influenced early elementary industrial arts programs (Dopp, 1902). This philosophy motivated the birth of the constructivist theory. Constructivist ideas are defined by Bentley and Watts (1994):

> Constructivism is a philosophy and psychology about the way people make sense of the world. The central point is that people are always intellectually active – they do not learn passively, but go out of their way to try to make some meaning in what is taking place in their environment. Our constructions of life are

> conditioned and constrained by our experiences and this means that – since we all have different experiences – we are all likely to have different perceptions about ideas, actions, behaviors, incidents, situations, tasks, feelings, and so on (p. 8).

Piaget (1929) promoted the constructivist theory by supporting the thought that knowledge is constructed in human beings when information comes into contact with existing knowledge based on experiences. They believe that children develop knowledge through active participation in their learning at different stages (Rummel, 2008). In essence, they viewed learning as a search for meaning.

To further illustrate how each theory relates to an elementary classroom or in young children it is helpful to consider examples of learning styles. Skinner believed that everything human beings did was controlled by their experience. Therefore, the "mind" (not the brain) had nothing to do with how people behaved. Furthermore, thoughts, feelings, intentions, mental processes, and so forth have no bearing on what humans do. The example of the Teaching Machine by Skinner (1958) exemplified the drill and practice routine much like what is found in standardized assessments used by our society today.

A study performed by Akpinar, Yildiz, Tatar, and Ergin (2009) explored the relationship between student attitudes towards science and technology of primary school students and their academic achievement in science. Using the Attitude Scale for Science and Technology (ASST) they found distinctive connections between attitude and achievement. They concluded "student attitudes tended to decline while grade level increased and that a considerable decline was recorded in the attitudes of particularly 8th grade students compared to other grade levels" (p. 2807). The results also suggested that students with high science achievement early in school developed positive attitudes towards science later on in schooling.

Strickland and Strickland (1998) discuss the problem of standardized testing with regard to the behaviorist perspective of instruction. "Because of the significance of test results and the immense pressure they exert, teachers too often find themselves teaching to the test, in order that their students do well and the teachers appear to be doing their job" (p. 205). Too many times school districts and the media equate high-test scores with successful education. On the other hand, performance assessment is a superior method of evaluating authentic learning.

> Performance assessment offer students a way to perform with knowledge, ways in which they can demonstrate what they have learned by combining the skills and knowledge acquired through course content with their prior and distinct knowledge of the world. Tests are admittedly one way to do this, but teachers must know how to provide opportunities in testing where students *do* science or history or language or philosophy. This is performance! (Strickland & Strickland, 1998, p. 71).

A constructivist approach to learning shown through a study by Tseng, Chang, Lou, and Chen (2013) illustrates the benefits of experiential learning. The purpose of this study was to understand students' attitudes towards science, technology, engineering, and mathematics (STEM) through the pedagogy of project-based learning (PjBL). Thirty, first-year college students with engineering backgrounds were challenged to design and build a "multi-function electric vehicle" artifact over the course of five weeks. The goal for the PjBL activity of producing the vehicle in this study provided an opportunity for the participating students to learn through group effort, group discussion and continuous examination. A valid and reliable instrument attitude questionnaire was administered. Overall, the results stated that students had the most significant changes in attitude towards engineering before and after the PjBL activity. In terms of learning strategies, students were more likely to acquire scientific knowledge through practical work. Combining PjBL with STEM influenced in student attitudes towards future career pursuits. As a result, the students have a more positive attitude towards the important learning style of combining PjBL with STEM.

Constructivist philosophers such as Dewey, Piaget and Vygotsky assert that learning is facilitated when lessons and activities are built upon students' prior knowledge, and when new ideas and concepts are correlated with students' previous experiences. These constructivists believe that knowledge cannot be directly transmitted. Instead, it has to be actively constructed by learners. “Constructivist pedagogy is thought of as the creation of classroom environments, activities, and methods that are grounded in a constructivist theory of learning, with goals that focus on individual students developing deep understandings in the subject matter of interest and habits of mind that aid in future learning” (Richardson, 2003, p. 1627). A constructivist classroom should be distinguishable by activities that are learner-centered; learning is seen as a process of discovery. Student learning needs, styles and strategies are essential to the development of the lesson (Richardson, 2003).

Conventional instruction is based on the idea that those who know teach those who do not know and in that transfer of knowledge, a learner’s task is to discover the world that exists. Somehow the *learning* must become meaningful. Changing from a behaviorist theory of learning to a constructivist theory of learning requires a paradigm shift for teachers and students. The underlying message is about improving instructional strategies and improving understanding that satisfies students, teachers, administrators, and stakeholders. Attitude assessment can provide intuition for this direction. It could be assumed that if students have a tendency to act positively toward a subject, for example technology, they will have more interest in that subject (Krathwohl et al., 1964).

Shepard (2000) presents a historical overview illustrating how changing conceptions of curriculum, learning theory, and measurement explain the current incompatibility between new views of instruction and traditional views of testing. The 20^{th} century paradigm consisted of a social efficiency curriculum, behaviorist learning theory, and scientific measurement. As the old paradigm dissolved as a result of looking at instruction and traditional testing, the emergent paradigm converges with a reformed vision of curriculum, cognitive and constructivist learning theories, and classroom assessments.

There is a crucial relationship between technological thinking and the constructivist approach to learning. Learning environments that are conducive for developing procedural knowledge depend on a process where students design and make products, test the product against stated criteria, and evaluate the outcome. Research performed in the affective domain, such as in the design-based process, indicates that students involved in a constructivist learning approach often display positive attitudes toward that subject (Popham, 1994). Essential to understanding the knowledge and attitudes students have about technology is to develop effective teaching strategies in TE (Bame et al., 1993).

Technological Literacy in the Elementary Classroom

Froebel, Dewey, Bonser, and Mossman believed that both interest and experiences of the child needed to be nurtured and that creativity and problem solving were just as important as technical skills. These concepts molded the early American industrial arts for elementary school, which served as a precursor to Technology Education as we know it today. In the 1980s, major institutions replaced the former “industrial arts” (IA) label with the term “technology education” (TE). Likewise, ESTE (Elementary School Technology Education) replaced the former elementary IA.

ESTE is “an educational program in which children engage in design and problem-solving, and/or constructional/manipulative activities to help them learn about themselves and the technological world around them” (Kirkwood & Foster, 1997, p. 3). In the beginning, the goal of IA was mainly to develop vocational skills but over time it was emphasized that courses in IA be more of a presence in elementary school. Wright (1997) further explains that ESTE is more than just a "watered-down" version of a secondary-level TE program. ESTE may be viewed from at least two different perspectives: as *content* or as a *constructive methodology* as well as *context*. Each approach contributes to the development of children and their technological literacy. Ideally, ESTE’s constructive methodology has the unique ability to help integrate and provide relevance to the elementary-school curriculum.

TE experiences in the elementary school are designed to help pupils learn and achieve the educational goals of the entire elementary school program. Design-based activities that encourage higher order thinking orients pupils to technology, helps to develop psychomotor skills, and provides the basis for informed attitudes about technology's influence on society. Technology-based activities, integrated into the total elementary school curriculum, motivate pupils and bolster learning while pupils gain technological awareness. Ultimately, the target of TE embraces the previously mentioned need for acquiring TL.

More than a decade ago Kirkwood and Foster (1999) issued a challenge for future researchers about the status of TE in the elementary school. First, there are many claims about the benefits of ESTE to children, but no conclusive evidence to support those. Second, ESTE does appear to enhance significantly career education efforts and increase students’ interest in other subject areas when used as a teaching method. Third, there is little empirical research validating the need for or value of ESTE in the United States at this time. Last, the successful implementation of ESTE must be based on the demonstrated need for technological literacy for all, not just on its ability to teach other subjects better. Wright and Foster (1996) advocate that ESTE enhances the following approaches: (a) children are more motivated via instruction through ESTE and will learn the other school subjects better and (b) technological content (knowledge and processes) will naturally be learned while students are engaged in constructional experiences, but are not of primary importance.

Elementary schools should be where we begin teaching problem solving, innovation, inventions, logical thinking, and making self-reliant thinkers. By weaving math, science, technology, and engineering together, as in STEM education, students will be able to see the clearer picture of how these disciplines relates to the real world as they progress through school, resulting in both increased and higher order learning. According to Bloom (1964), children from conception to age four, develop 50 percent of their mature intelligence; from age four to eight, they develop another 20 percent. The implication is that at age five, the year they attend kindergarten, instruction can only influence less than half of the intellectual development of the child. Children need to have concrete experiences in order to learn technological concepts. It is crucial that educators take advantage of this critical embryonic time to begin their experience of technological thinking. Stables (1997) supports this as well:

> Introducing technology into the curriculum of young children is also important because of the propensity of this age group to engage in technological activity with an enthusiasm, curiosity and lack of inhibition that creates an optimum opportunity for development. Children's sheer excitement, wonder and enthusiasm for the world around them make for an era of rapid development. In the pre-school years, the child's lack of concern for external constraints allows for a free exploration of both their material and conceptual world. Curiosity as to how things work leads to a determination to make things work (p. 51).

STEM education intends for all students to have a thorough understanding of science, technology, engineering, and mathematics. Science for All Americans' (AAAS, 1990) goals addresses what the next generation needs to know and be able to do in science, mathematics, and technology, emphasizing that these are the means of making them science literate. They stress the importance of knowing and understanding the relationships between science and technology and that content of science lies in the cognitive domain while attitudes about science lie in the affective domain. The National Science Teachers Association (1997) stated the following:

> Children are naturally interested in the human-made (designed) objects such as toys, buildings, automobiles, bridges, can openers or doorknobs. Designed objects and materials are an essential element of a child's environment . . . The technological design process in some ways resembles scientific inquiry. . . At the elementary level, technologic design stimulates and engages children in a variety of critical thinking skills (p. 81).

To summarize, Elementary School Technology Education is the optimal setting by which T/E design-based teaching/learning can be experienced by children. Exposing students, especially young children, to technological concepts and hands-on, design-related activities is the most likely way to help them acquire the kinds of knowledge, ways of thinking and acting, and capabilities in harmony with Technological Literacy. The emphasis on developing Technological Literacy in elementary students and articulation of the need to begin TE early in a child's formative years is reinforced by several prominent researchers in the field (Cunningham, Lachapelle, & Lindgren-Streicher, 2005; Kirkwood & Foster, 1997; Wright, 1999).

Attitudes and Elementary Students' Technological Literacy

Attitudinal assessment can assist educators. Instructors, at any level, can discover which components of their course contribute most significantly to students' learning. General information on students' beliefs about the nature of subjects is beneficial in designing activities to foster a more realistic view of a discipline. The attitudinal assessment provides valuable information on student perceptions of their classroom experience and identify elements in instruction which best support student learning.

Attitudinal research can help in providing information about what ideas students have about design and how these ideas can either help or obstruct their learning. This research also helps teachers and curriculum developers to develop instructional activities that guide students' thinking toward these ideas by providing relevant phenomena and useful questions that can motivate, stimulate, and support students (Cajas, 2000).

Assessment of attitudes addresses needs of the student, how well those needs are met, student interest in or appreciation for the subject matter or field, student confidence in their ability to perform, and their beliefs about the nature of the discipline itself. When doing an assessment students are prompted to reflect on their own learning preferences, strengths, or styles and become managers of their own learning.

Kobella (1989) discusses how teachers should adjust their teaching based on attitude change by suggesting that attitudes can be changed in as short a time as one class period, provided that attention is paid to the variables harbored within the question: Who says what to whom how with what effect? *Who*, the communicator, can facilitate attitude change when his credibility is respected. *What*, the message, is using teaching strategies that are innovative and employs a constructivist approach. *Whom*, the recipient, attitude change and persistence are linked to the active participation of the recipient as he elaborates upon the message's arguments and evidence. *With what effect*, the measurement, should be the focus of formal evaluation and should be deemed valid and reliable and adequately measure the construct.

Kobella (1989) also emphasizes these ideas about why we assess attitudes. Attitude instruments provide us with a convenient means of assessing behavior. The only true reason for studying attitude is its relationship to behavior. The prediction of behavioral intention, and hence behavior, is improved when the elements of the attitudinal and behavioral intention variables are calibrated at the same level of specificity as the behavioral criterion. Without reliable and valid measures of attitude, assessing attitude change is impossible.

Attitudinal Research

Understanding relationships between positive attitudes and building technological literacy in elementary students is emphasized by the importance of attitudinal research. Attitudes are viewed as a person's general psychological tendency toward a particular entity with some degree of favor or disfavor (Eagly & Chaiken, 1993). According to Myers (2010), "Attitude is a favorable or unfavorable evaluative reaction toward something or someone exhibited in ones beliefs, feelings, or intended behavior" (p. 36). The underlying inclination to respond to something either favorably or unfavorably situates this as a social matter. The idea of attitude is multifaceted based on preferences and opinions despite its apparently simple everyday practice. Norland (1994) says that attitudes are complex and have the following traits: attitudes have a direction, attitudes have strength, attitudes have an object, attitudes last, and attitudes are formed. Attitudes are used by individuals in categorizing the object of the attitude in some way, and to provide evaluative meaning to such objects (Eagly & Chaiken, 1993; Kruglanski & Stroebe, 2005). Attitudes provide meaning to an object or person by placing it within the existing knowledge structures held by an individual (Fishbein & Ajzen, 1975; Schwarz, 2007). Attitudes formed following direct experience with the attitude object are better predictors of future behavior than are attitudes formed following indirect experience (Bohner, 2011). From these definitions it can be deducted that when students favor a subject in school there will be positive learning outcomes.

With emergence of the “behaviorist model” in professional education circles, affective behavior has received increasing amounts of attention from educational researchers. In the attitude-behavior relationship it is generally realized that attitudes are relevant for understanding and predicting social behavior. Other research on attitudes, as precursors of behavior, shows that implicit measures of attitude predict spontaneous, less controllable behavior, whereas explicit measures of attitude predict deliberative, more controlled behavior. Jointly, implicit and explicit measures of attitude may improve the overall prediction of behavior and overt action (Ajzen, 2011; Bohner & Dickel, 2011).

The purpose of attitudinal research is usually to understand, measure, or inform change of people's stated beliefs. An attitudinal survey, also known as an affective survey, can provide information on a person’s perceptions, emotions, feeling, and attitudes, of their experiences. Another purpose of conducting attitudinal research is to give insight into how attitudes influence behavior and how each entity of the integrated affect/cognition/behavior system influences student learning. If one of the educational goals of technology education were to obtain technological literacy, then students who exhibit a positive attitude toward technology would be more likely to attain technological literacy through technology education (Bame et al., 1993).

McLoughlin and Young (2005) concluded that evaluation from assessments provides feedback loops that are critical to the ongoing design of better educational programs.

Researching Pupil’s Attitudes Toward Technology

The *Rising above the Gathering Storm* (National Academy of Science, 2006) report emphasized a critical need for achieving technological literacy among America’s K-12 students. An effective technology education program is built on the understanding of students’ knowledge of and attitudes toward technology. For many years there has been an emphasis on determining student perceptions and attitudes toward technology affect and relate to their learning about it. de Klerk Wolters (1989) stressed that understanding the situation of pupils' attitudes and concepts towards technology will help course designers and teachers know how to assist pupils in learning about technology.

This study involves an attitudinal instrument that has been utilized since 1985. The original PATT instrument contained 85 items addressing a range of technology issues by Raat and de Vries (1985) and was used with middle school aged children in the Netherlands. Their results from the study were recognized internationally. As a result, in 1988, Dr. William E. Dugger from Virginia Polytechnic Institute and State University (Virginia Tech) was instrumental in launching this same research in the United States. Dr. Dugger, along with Dr. Allen Bame (Virginia Tech), developed a PATT-USA instrument for use in the United States. With assistance from Dr. de Vries, the instrument was translated from Dutch to English.

In 1984, research began in the Netherlands to determine attitude and concepts toward technology by students aged 12-15 years. Originated from a project called "Physics and Technology" the Pupils' Attitude towards Technology (PATT) study was developed by Dr. Marc de Vries (University of Technology in Eindhoven, The Netherlands), Dr. Jan H. Raat, and a team of researchers, in order to seek out the ideas that students have about technology. After testing 2500 eighth grade pupils to determine their attitude and concept about technology they concluded that students had vague and incomplete concepts about it as well as revealing significant differences between girls and boys in their attitudes about technology (Bame et al., 1993). Other conclusions exposed that students, particularly girls, had a very obscure understanding of the relationship between physics and technology and that girls are less interested in technology and consider it less important than do boys of the same age group (Raat

& de Vries, 1985). This knowledge had an impact on teaching methods and curriculum development.

Interest, role pattern, consequence, difficulty, curriculum, and career were first defined as the six factors making up attitudes toward technology by Raat and de Vries in the PATT study (Kuang-Chao, Kuen-Yi, Feng-Nien, & I-Ying, 2012). The PATT instrument was developed addressing a range of technology issues by Raat and de Vries (1985). Five components developed by the PATT investigators included an attitude toward technology questionnaire, an understanding of the concept of technology questionnaire, essays, drawings and open ended questions to get additional information about concept of and attitude toward technology, a technology attitude scale (a short version of 1 and 2), and a teacher attitude scale to assess teacher attitudes regarding technology (Raat, 1992).

Dr. de Vries, then editor in chief of the International Journal for Technology and Design, shared his motive for developing this instrument. “In the Netherlands, at a certain moment the introduction of a separate subject 'Technology' was considered by the government. I realized that in order for such a subject to become successful, teachers would need to address the pre-concepts that pupils have about technology and know about the attitudes they have formed based on previous education, parents, peers, TV, etc. To find that out, I did a nationwide survey to measure 13-14-year-old pupils' ideas about technology (what do they think it is and how do they feel about it). I started with interviews to get a first impression of possible dimensions in the attitude, then constructed a questionnaire, field-tested it, revised it and in the end I got six valid and reliable scales (interest, gender, importance, accessibility, good/bad, and career/education)” (M. de Vries, Personal communication, March 19, 2013).

This research spurred interest at an international level because of notable results. It has been administered dozens of times in many countries since 1988 (National Academy of Engineering and National Research Council, 2006, p. 96). PATT conferences, in conjunction with the International Technology and Engineering Education Association (ITEEA), have been held annually or biannually since 1985 to bring together experiences in PATT research, discuss developments in technology from an international perspective, and to discuss the relevance of PATT studies for development efforts (de Vries, 1992). The purpose of this research has been to "integrate what pupils think of technology and to use the results of this research for the development of the new subject technology in primary and secondary school education" (de Klerk Wolter, 1989, p. 291).

In 1988, Dr. William E. Dugger from Virginia Polytechnic Institute and State University (Virginia Tech) was instrumental in launching this research in the United States. Dr. Dugger, along with Dr. Allen Bame (Virginia Tech), developed a PATT-USA instrument for use in the United States. With assistance from Dr. de Vries the instrument was translated from Dutch to English. Analysis of this new instrument consisted of:

1. A frequency analysis of all measured variables.
2. A factor analysis of the attitude items.
3. A Guttman analysis of the concept items.
4. A reliability analysis of the attitude and concept items.
5. Test (*t*-tests) on the attitude and concept scale score with subgroups based on gender, age, grade, rural or urban school area, parents' profession, technological climate at home, and quality of a definition of technology (Bame, et al. 1993, p. 40)

The PATT-USA (Appendix A) consists of items 1–11 on demographical data; items 12–69 on the *affective component* of attitudes towards technology; items 70–100 on the *cognitive component* of attitudes towards technology; an open ended question that asks for a simple description of technology (de Vries, Dugger, & Bame, 1993). The first section asks for a short description of what students think technology is. Eighty-eight statements about student attitudes and concepts make up the third and fourth part to which students were to respond using a Likert scale. The third part has 57 statements with a five-point Likert scale about assessing the attitude toward technology while the last part of the instrument contained 31, three-point Likert items, which targeted concepts of technology. Each item is related to a student's interest in technology, perception of technology and gender, perception of the difficulty of technology as a school subject, perception of the place of technology in the school curriculum, and ideas about technological professions (National Academy of Engineering and National Research Council, 2006, p. 115). The attitude statements were categorized into these six attitude subscales:

1. Interest in technology (interest)
2. Technology as an activity for boys and girls (gender)
3. Consequence of technology (consequences)
4. Perception of the difficulty of technology (difficulty)
5. Technology in the school curriculum (curriculum)
6. Ideas about technological professions (careers).

Four concept subscales were also measured. They were:

1. Relationship between technology, human beings, and society (technology and society)
2. Relationship between technology and science (technology and science)
3. Skills in technology (technology and skills)
4. The raw materials or "pillars" of technology (technology and pillars).

(Bame et al., 1993, p. 40)

The researchers validated that the PATT-USA measured attitudinal changes in perceptions toward technology, which could be related to developing TL in the United States. The test was administered, resulting in 10,349 usable instruments, from 128 schools in seven states: Virginia, New Jersey, Wisconsin, Ohio, Oklahoma, Florida, and Utah. Results of the PATT-USA study indicated that: (1) students are interested in technology; (2) boys are more interested in technology than are girls; (3) students in the US think that technology is a field for both girls and boys; (4) girls are more convinced that technology is a field for both genders; (5) there is a positive influence of a parents' technological profession on the students' attitude; (6) US students' concept of technology became more accurate with increasing age; (7) US students are strongly aware of the importance of technology; (8) the US has a rather low score on items measuring the concepts of technology compared to other industrialized countries; (9) students who had taken industrial arts/TE classes had more positive attitudes on all sub-scales and; (10) the existence of technical toys in the home had a significantly positive impact on all attitude scales (Bame et al., 1993).   There were also attitudinal differences between those who had experienced technology classes and those who had not. Student conceptual understanding of technology differed between students in the United States and other countries as well.

After the administration of the PATT and the PATT-USA by Raat, de Vries, Bame, and Dugger, the research suggested that teachers develop their teaching strategies and select the most effective method for implementing TE based on students' attitudes toward technology. In other words, use the results of the assessment to find the most effective way to implement TE. An understanding of students' knowledge of and attitudes toward technology is necessary and is a prerequisite to effective teaching about technology (Bame et al., 1993).

With no accepted or standardized cognitive measures of TL, Boser, Palmer, and Daugherty (1998) recommenced research using the PATT-USA, as a standardized attitude measure, for gaining knowledge about effective teaching approaches to positively affecting students' attitude toward technology. They stated, "the attitude measure may then be one indicator of effective teaching approaches for technology education" (Boser et al., 1998, p. 4). They hypothesized, from research in the affective domain, those students who have a positive experience in a TE program will develop a positive attitude toward it and that this positive attitude toward technology would lead to interest in studying about technology and pursue careers that lean in that direction. More recently, De Vries stated:

> From the PATT studies it can be concluded that pupils who have a narrow view of technology, have less positive attitudes towards technology. Unfortunately, but not fully accidentally, these pupils tend to be mostly girls. Girls usually have more interest in the social and human aspects of technology, but these aspects are rarely associated with technology. Because of their narrow concept, they are hampered in their development of a positive attitude. Therefore, it is of great importance that at primary schools technology education is taught in a way that provides a comprehensive concept, including the human and social aspects (de Vries, 1999).

No such instrument has been developed for students younger than 12–15 years of age. Since it is equally important for elementary students to develop technologically literacy a tool should be developed to assess their conceptions and attitudes of technology, which leads to attainment of TL. A list of studies involving the PATT instrument before 1993 is presented in Table 1.

Table 1.

PATT Studies Performed prior to 1993

Country	Number of Pupils in the Sample
Poland (1)	3
Poland (2)	678
Kenya	244
United Kingdom	173
India	625
Italy	566
Nigeria	303
Australia	212
France	234
Denmark	152
Mexico	213
The Netherlands (1)	2,469
The Netherlands (2)	2,050
The Netherlands (3)	1,257
Belgium	190
United States	10,349

De Klerk Wolters added that Canada, Hungary, Surinam, Sweden, and Zimbabwe had also participated in studies involving this instrument (de Klerk Wolter, 1989). Numerous PATT studies after 1993 have been done (Appendix B).

When the PATT instrument was first developed it was found to be both valid and reliable. Researchers in 11 countries conducted pilot studies with translated questionnaires and from those results this instrument was developed and proven to be reliable and valid in Western countries (Raat et al., 1989). In 1998, Boser, Palmer and Daugherty used the PATT-USA instrument in conducting research to assess technological literacy in students who received technology education in different approaches, such as modular and integrated approaches. While there were slight indications that one approach was better than another the researchers stated that a larger scale study would be needed to draw any meaningful inferences among instructional approaches. However, as far as the instrument was concerned they stated that "the

PATT-USA appears to be a suitable instrument for this assessment and …that students' attitudes toward technology and their concept of technology were generally consistent with previous PATT and PATT-USA studies” (Boser, Daugherty, & Palmer, 1998, pp. 17-18).

In 1999, van Rensburg & Ankiewicz conducted research using the PATT analyzing sex difference in relevant attitudes on South African students’ attitudes toward technology. It was expected that data would not be as valid and reliable in Southern Africa as in monolingual, developed First World countries functioning in a technological society. A follow-up study using the ATP (Attitudinal Technology Profile) was performed in 2001, initiated by the government to ensure effective introduction of Technology Education for South African schools, was implemented. The reason for the second study was because the PATT data was not as valid and reliable in South Africa as in the other 20 countries, including some developing countries, in which it was applied. “The explained variance was a rather low 24.4% and a Cronbach alpha reliability coefficient of 0.66 resulted” (Ankiewicz & van Rensburg, 2001, p. 95). The ATP questionnaire provided more reliable and valid results in the South African context than its western counterpart (van Rensburg, et al., 1999). Comparing the PATT to the ATO resulted in a 0.66 to 0.78 according to the reliability (Cronbach Alpha) score. The researchers also felt the validity of the extended ATP questionnaire should be improved by further qualitative research.

In Asia studies performed by Volk and Yip (1999) analyzed sex differences in student attitudes. They revised the PATT-USA instrument into a PATT-HK instrument and assessed 3,500 Hong Kong junior high students. Later, Volk et al. (2003) executed a second study, PATT2-HK, where they tested before and after implementation of a design and technology course. 2,800 junior high students were assessed.

Researchers in Taiwan focused primarily on developing specific instruments for particular target populations. Yu, Han, Lin, & Hsu (2005) developed a suitable instrument for junior high students by drawing on the PATT series of instruments to allow Taiwanese scholars of technology education to be able to design research consistent with norms internationally. This resulted in the development of the Attitudes Toward Technology Scale.

A study in South Africa by Gaotlhobogwe (2012) concluded that “The PATT instrument did not yield valid and reliable results from the South African learners because of differences in language, terminology and contexts between developed first-world countries and Southern Africa” (p. 12). Meide (1997) claimed the following: “The results of PATT Botswana added to the knowledge base for educators who wish to gain understanding of the attitudes and concepts of technology among the Form 5 pupils of 1993” (p. 213). These references supported the assumption that the PATT questionnaire could be applied in South Africa.

Rennie and Jarvis (1995) stated that the validation of the descriptive framework of their study was assisted by discussion with technology curriculum experts, who examined the classification and the activities to attest to their representativeness and that the (PATT) instruments are amenable for research use, particularly by teachers in their own classrooms.

The PATT instrument has been used and adapted for countries all over the world. de Vries (1999), stressing the need for the gathering of empirical evidence, identifies some barriers and stumbling blocks as researchers strive to gather evidence of the impact of TE. The following barriers are listed below.

1. The successful introduction and realization of TE as relatively new and not yet generally accepted as a school subject as perceived by pupil, teachers, administrators, and stakeholders.

2. Teachers not only need content knowledge and skills of TE they also need pedagogy training aligned with school issues, which is burdensome.
3. There is still a lack of research instruments to provide the empirical evidence of impact of TE along with methodological issues of the existing PATT instrument.
4. Economic and political issues impede TE in some countries around the world and the investigation thereof.

Since the PATT instrument was created many years ago some issues with the design are of concern. While it is a valid and reliable instrument for use in the United States it was not formatted for administration on a computer. It will be computerized since students are already comfortable using computer technology for taking standardized tests.

Surveying Elementary Students

Survey methodology as a scientific field seeks to identify underlying principles about what is being studied as well as promoting changes in public attitudes. The quality of social science measurements, either directly or indirectly, is based on the efficiency of both the instrument and the delivery of the instrumentation. Measures of assessment refer to the methods, processes, or tools used to evaluate students' performance in context of intended student learning outcomes. Surveys, a primarily indirect assessment measure, are a systematic means of collecting data from a group of people in order to describe some aspects, characteristics, or perceptions of the population begin questioned. These questions are designed to measure a dependent variable and independent variables of interest. Therefore, the precise meaning of a question may be much influenced by accurate wording.

There are a myriad of approaches to surveying. Surveys can be pen-and paper mail-out surveys, face-to-face interviews conducted via webcam, simple questionnaires administered in different environments or through a multiple of other different strategies. Quantitative and qualitative data collection strategies can and should be employed to holistically analyze data. Quantitative oriented research solicits closed-ended questions while qualitative questions are open-ended. Surveys can be freestanding or can be embedded in larger research designs such as ethnographies, case studies, or experimental research.

Student attitudinal change surveys include elements of appreciation and/or understanding of particular issues of concern, in relation to the learning outcomes expected. These indirect measurements, such as a survey, questionnaire, or exit interviews, are where students judge their own ability to achieve a learning outcome rather than directly measuring a student's product or specialized tests. Surveys are beneficial because of the simplicity of administering the system but there are concerns and limitations about the problem of measurement error. Information from a questionnaire must be translated from a set of specific questions.

Questions 1 – 11 require non-Likert type responses but the remainder of the instrument is a Likert scale. It requires that individuals respond, either negatively or positively, to a set of carefully designed statements about a certain construct and the criteria for designing statements is based on that they are opinions rather than facts, they are clear and concise, and they involve one variable of the construct. After a trial administration Likert type statements are evaluated through item analysis and items are retained in the scale based on those results. Typically there are five positions on the scale where respondents are asked to document their perceptions from total agreement to total disagreement. For those who hold extreme attitudinal positions there are validity concerns with the Likert assessment. It may not accurately measure that construct. The PATT instrument uses the Likert format but items are not typically extreme laden with sensitive subjects.

In 1999 van Hattum and de Leeuw did a study comparing data quality in self-administered computer-assisted questionnaires and self-administered pencil and paper among children and found far less variability in the computer-assisted method. They stated that students could easily skip a question or page either by mistake or by intention when bored on paper questionnaires. They also discovered a correlation between age and reading abilities of students resulting in younger children producing more item non-response as well as gender significance. Girls are slightly better at responding then boys.

Accurate data collection is essential to maintaining the integrity of research. Using a validated and reliable instrument with clearly delineated instructions for its' correct use reduce the likelihood of errors. Whitney, Lind, and Wahl (1998) stated that quality assurance pertains to the activities that take place *before* data collection begins, and that quality control involve activities that take place *during* and *after* data collection.

Research on self-administered surveys suggests that the design of the instrument may be extremely important in obtaining unbiased answers from respondents. The format of survey items and arrangement of these items has an effect on the appearance of the survey and, of great importance, can affect the values of the responses obtained (Couper, Traugott, & Lamias 2001). According to Childers and Skinner (1996) quality factors in surveying include color, attractive design and other appearance related features of a questionnaire and affect respondents' perception of the survey's professionalism. In the case of children, these things stimulate children's desire to want to take the survey. This perception is linked with a greater sense of trust and a higher level of cooperation.

West, Hauser, and Scandlin (1998) stressed these ideas in their study of longitudinal surveys dealing with children. An age appropriate, many-item scale is split into overlapping blocks, and the person answers only a few items at a time. "The current practice for collecting data on child development is to apply existing standardized assessment scales. Such scales are often too long and too difficult to administer in a survey where only a short period of time is available for data collection" (p. 14). Questions should have clear instructions, be well designed, and unambiguous.

As children grow they are developing and learning new skills in the process that makes it difficult to make a one size fits all survey or questionnaire. Thus, looking at the developmental stages helps frame what is appropriate for certain levels. Children in the fifth grade typically fall between the ages of 10 and 12. This classifies them as functioning on Piaget's (1929) concrete operational stage. It is in this period that language and reading skills are acquired. de Leeux (2005) states that children, below the age of seven "do not have sufficient cognitive skills to be effectively and systematically questioned" (p. 831). Also, between the ages of 10 and 12 there is progressive understanding that one can have two different feelings at the same time and to be developmentally dependent (Carroll & Steward, 1984).

In this stage children are able to be surveyed due to the development of establishing points of view and are still very literal in the interpretation of words and experience the same problems as younger children with 'depersonalized' or indirect questions (Borger, de Leeux, & Hox, 2000). It is at this stage that cognitive, memory, communicative and social faculties are still developing.

Borgers et al. (2000) asserted that at the concrete operational stage children can begin using appropriately designed, self-administered tests in the classroom. Borgers et al. (2000) also suggested that when surveying children, strong consideration should be given to questionnaire construction, and questionnaires should be carefully pretested. Survey design for any of the children age groups should regard the cognitive and social development of young respondents. For fifth graders who are sufficient in reading and language skills, self-administered group testing or even computer-assisted testing is an appropriate method of collecting data. In essence, the older the child is the better the data quality. Based on collective research presented thus far it is perceived that a fifth grade student's attitudes toward technology could be assessed by using a validated and reliable existing instrument.

Children's attitudes and dispositions play a vital role in technology education. Surveying fifth grade students is one way to gain understanding of children's existing beliefs and attitudes. Given that information, teachers can better make instructional plans to help their students become more confident, enthusiastic, and autonomous learners. This can strengthen this direction that TL for all is being attained.

Summary of Literature Review

The works of early theorist such as Frobel, Dewey, and Bonser and Mossman, influenced our understanding of how children learn and develop. They were instrumental in changing the public's mindset of children being empty vessels to be filled and shaped to a more, progressive approach which promoted society looking at children as individuals, focusing on their strengths and varied learning styles. The Industrial Arts movement was beneficial in allowing students to learn skills that translated into life.

The continuous technological advancements we experience today have mandated a change in how all students view technology and how they embrace the future. More than ever, education and society must come to grips with how to prepare all students, including elementary, for the 21st century. STEM education reform and ever-evolving Technology Education (TE) programs are addressing this need and have implemented various strategies concentrate on acquiring TL for our nation's students. A new initiative is focused on developing Technological Literacy (TL) for the younger, elementary level student.

In the *Technology for All Americans Project*, the ITEA (1996) states the main goal for the field of TE is to promote TL. TL correlates with the attitude toward technology, therefore, when assessing and measuring TL as an outcome of education, one should consider attitudes toward technology. As expressed within in the literature on attitudinal research, attitudinal change surveys are indicators of student perceptions about a phenomenon. Attitudes are judgments that reflect affective/behavior/cognition domains, which, in turn, reflect student's learning. This can have a significant effect on their overall level of attainment of their experience of education. In this case it would be the attainment of TL. Logically then, in order to effectively deliver TE to elementary students an investigation of attitudes is needed to guide our efforts.

In 1999 Marc de Vries (1999) voiced recognition of the need for research to determine whether or not TE is fulfilling its promise to create TL in students. He stated:

> Can we really say that Technology Education created technological literacy with our pupils and students? Can we say that we have been able to change their concepts and attitudes toward technology, so that they have acquired a balanced perspective on technology and a positive, but not uncritical attitude towards it? Is their (sic) any empirical evidence that Technology Education is really doing the job that it was announced to do (p. 115)?

Dr. de Vries, speaking of the original PATT instrument, also stated a repertoire of research instruments needs to be developed to provide empirical evidence of the impact of TE.

With no accepted or standardized cognitive measures of Technological Literacy, the PATT and PATT-USA studies, a standardized attitude measure for middle and high school students, provided a platform for investigating students' attitude toward technology. However, the lack of such instrumentation for examining children's attitudes toward technology at the elementary level remains a gap in research and therefore provides the focus for this study.

CHAPTER THREE:

METHOD

This chapter describes the method used in conducting an investigation based on the following research questions. The sections for this chapter include the research design, participants, data collection procedures, and data analysis.

The following research questions (RQs) and sub-questions (Sub-Qs) direct this study:

RQ1. To what extent is a modified PATT Instrument (PATT-ELEM) a valid tool to assess fifth grade students' attitudes toward technology?

Sub-Q1: What level of content validity can be established in measuring fifth grade attitudes toward technology?

Sub-Q2: What level of construct validity can be established in measuring fifth grade attitudes toward technology?

Sub-Q3: How suitable is the readability level of the PATT-ELEM instrument for fifth grade students?

Sub-Q4: What level of reliability can be established in measuring fifth grade attitudes toward technology?

RQ2. What are fifth grade students' attitudes toward technology?

Research Design

The goal of a descriptive, cross-sectional research design is to analyze data collected from a population without changing the environment in a one-time interaction. Validating the use of a modified version of the original PATT instrument, a survey instrument, with elementary age children is the objective of this research. This non-experimental research design is intended to establish readability, validity (content and construct), and reliability of the modified PATT instrument for use with elementary students as a tool for measuring fifth grade student attitudes towards technology. The result will be the PATT-ELEM, a viable instrument for measuring elementary student attitudes toward technology.

Method

Participants

The participants selected for this study were fifth grade students from a PK-5 elementary school located in a rural county in northwest Virginia. Fifth grade students were selected, rather than younger students, for the following reasons: (a) they are considered functional readers because of their rapid development of decoding and fluency skills, (b) they are familiar with using computers, and (c) they are able to comprehend the content of the survey instrument. The target school has a population of approximately 575 students with approximately 100 fifth grade students. The distribution of male to female students is 301males to 265 females. Students at this school are categorized in ethnicity as 83% White, 9.5% Hispanic, 1.6% Black/African American, and less than 1% American Indian/Alaskan.

All fifth grade students currently enrolled in this school, distributed among five classrooms, were invited to participate in the survey. Prior to collecting data, the researcher gained approval from the Institutional Review Board (IRB) from the Board of Human Subjects at Virginia Tech for conducting research with fifth grade students (Appendix C). The researcher provided the fifth grade students and their parents with a study recruitment document, parental permission form, and student assent form. Only the students who return the IRB approved forms (parental permission and student assent appropriately signed) could participate in the study (Appendix D).

Instrumentation

The PATT-USA instrument (Dugger & Bame, 1988) is comprised of 100 items and divided into four parts. Part One consists of a single item, asking the respondent for a short description of technology. Part Two consists of 11 items that gathers demographic data from the respondents. Part Three include 57 items, (a five-point Likert scale ranging from Agree to Disagree assessing attitudes toward technology) consisting of attitudinal statements organized into the following six scales:

1. Interest in technology (interest)
2. Technology as an activity for both boys and girls (gender)
3. Consequences of technology (consequences)
4. Perception of the difficulty of technology (difficulty)
5. Technology in the school curriculum (curriculum)
6. Ideas about technological professions (careers)

The last 31 items comprise Part Four of the instrument and ask respondents about their concepts regarding technology. Items in this section of the instrument are statements addressing technological concepts and organized into the following four scales:

1. Relationship between technology, human beings, and society (technology and society)
2. Relationship between technology and science (technology and science)
3. Skills in technology (technology and skills)
4. The raw materials or “pillars” of technology (technology and pillars)

Responses for these last 31 items employ a three-point Likert scale ranging from Agree, Disagree, or Don’t Know.

Dr. de Vries, one of the creators of the first PATT instrument, was contacted about the data analysis performed on the first PATT assessment. de Vries stated, “I did not use a readability test, but used a pilot test with pupils. Validity was established with a factor analysis. For each of the factors the items related to that factor clearly formed a coherent set. Reliability of the scales was established through Cronbach's alpha, a standard way of doing that” (M. de Vries, Personal communication, September 17, 2014).

Procedures for Instrument Modification

The process of modifying the original PATT USA instrument to address issues of relevancy and validity is described in the following sections. Establishing instrument relevancy and validity will require review by a panel of judges who have expertise on technological literacy at the elementary level. The researcher identified and selected a single panel of experts for accomplishing both the correction of terminology and the instrument validation. Content and construct validity, as described in the following sections, were performed to ensure the usefulness of the data from the PATT-ELEM as modified.

Expert Panel Selection. Fraenkel and Wallen (2003) characterizes the type of experts needed for validating content and constructs as an individual who can be expected to render an intelligent judgment about the adequacy of the instrument – in other words, someone who knows enough about what is to be measured to be a competent judge” (p. 161). Lynn (1986) recommended a minimum of three such experts for content validation. Guided by this approach to selecting a panel of experts the researcher invited three participants to serve on a content/construct evaluation panel based on their expertise in the subject matter of the PATT-USA at the elementary level. Panel members were supplied with a cover letter, instructions, and the protocol, which is an electronic version of the PATT-USA instrument. Panel members were asked to respond within a two-week window.

Criteria for expert selection for this study consisted of those having (1) five or more years teaching experience teaching technology education (TE) to elementary or middle school students, (2) course preparation classes at the university level in TE, and (3) were experienced middle school TE teachers who have worked with elementary students. Consensus is the goal of instrument evaluation by the panel, which is achieved by establishing an acceptable level of inter-rater reliability.

Interrater Reliability. Interrater reliability is a measure of reliability used to assess the degree to which different judges or raters agree in their assessment decisions. An inter-rater reliability analysis using the Kappa statistic was performed to determine consistency among raters. Fleiss' kappa (Fleiss, 1971) works for any number of raters giving categorical ratings to a fixed number of items. Agreement can be thought of as when a fixed number of people assign numerical ratings to a number of items. The kappa will then give a measure for how consistent the ratings are. The kappa formula is defined as:

$$\kappa = \frac{\bar{P} - \bar{P}_e}{1 - \bar{P}_e}$$

The factor gives the degree of agreement that is attainable above chance, and, gives the degree of agreement actually achieved above chance. If the raters are in complete agreement then $\kappa = 1$. If there is no agreement among the raters other than what would be expected by chance then $\kappa \leq 0$. Acceptable agreement would be indicated by a score of 1.00 (Lynn, 1986). This process of establishing inter-rater reliability and level of consensus was applied in determining both content and construct validity.

The steps necessary for investigating the research questions for data collection and analysis are organized into four distinct Phases. Those are Phase 1: Correction of Terminology, Phase 2: Establishing Instrument Content and Construct Validity, Phase 3: Establishing Instrument Readability, and Phase 4: Instrument Reliability.

Phase 1: Correction of Terminology

Phase 1 was necessary due to the age of the instrument. Since 1988 many technological changes have occurred which implies possible misunderstandings or confusion in the language of the original PATT survey instrument. Certain technological terminology used during that time period could be viewed as irrelevant and invalid for the present context. This might be obscure or unfamiliar for the fifth graders taking the survey today. As a result of these discrepancies the initial instrument may not accurately measure the attitudes and concepts perceived by students. Therefore, to ensure the PATT-ELEM instrument will reflect appropriate contemporary technological terminology this instrument must be modified prior to being administered to the student participants. Permission has been granted by Dr. de Vries (M. de Vries, Personal Communication, Appendix E, February 3, 2015), the original creator of this instrument in Dutch, to use and modify this instrument for research.

In order to make the PATT–ELEM instrument contemporary, correction of terminology was established through expert reviews. An established and widely used method for analyzing the appropriateness of key terms within text is selecting words that are problematic for review by experts. A preliminary review of the original PATT-USA instrument was conducted by select experts and was determined that most of the content is satisfactory. Therefore this expert panel review will address only those items that were potentially problematic.

Expert Panel Review

As previously stated the criteria for selection of experts was described. Expert panel members received an electronic version of the original PATT-USA instrument along with a scoring rubric of the highlighted, problematic words that needed to be evaluated (Appendix F). This document included instructions on how experts were to respond.

The procedures followed for this expert panel review were: (a) review shaded words or phrases from the scoring rubrics that appear obsolete from a preliminary review, (b) indicate whether the word or phrase in question is current and did not need modification or is outdated and needed modification, (c) provide alternative words or phrases in the designated area on the rubric, and (d) return to researcher. Depending on the analysis of this correction of terminology the researcher may return to the group to get consensus on the best word to replace the problematic word(s). The expert panel was asked to return the scoring rubric within a two-week window. Once group consensus was gained concerning modifications the researcher proceeded with the retention/elimination/modification of problematic words. The resultant, modified instrument was renamed the PATT-ELEM (Appendix G).

Establishing Instrument Validity

Validation of an instrument is based on the appropriateness, correctness, and the efficacy of the deduction a researcher makes. The PATT-ELEM instrument was derived from the PATT-USA and although the ten subscales measuring attitudes and perceptions previously used in this instrument were believed to be transferable, validation by the panel of independent experts (judges) was required. Fraenkel and Wallen (2003) present three steps that are usually involved in gaining content and construct validity. First, the variable being measured is clearly defined. Next, the theory-based hypotheses, basic to the variable, are formed about how people who possess a “lot” versus a “little” of the variable will act in a certain way. Last, this hypotheses will be tested, both logically and empirically. In Phase 2 the independent panel of judges will evaluate survey questions for content and construct validation using a common set of procedures as described in the following section.

Phase 2: Content and Construct Analysis Procedures

The purpose of Phase 2 was to establish content and construct validity. Expert panelists were provided instructions on how to perform content and construct analysis on an electronic version of the PATT-ELEM instrument (Appendix H). Rubric instructions for analyzing the instrument began with an operational definition of the PATT-ELEM instrument. The steps for both content and construct validation procedures will be conducted concurrently. The goal of Phase 2 was to reach consensus as a group that the PATT-ELEM instrument was valid in both content and construct.

Content Validity. Lynn (1986) defines content validation as a rigorous assessment consisting of a two-stage process (development and judgment quantification) that is fundamental to validating virtually all instruments. The process of validating content is as follows. First, a definition of what is to be measured as well as the instrument that is being considered is provided for a minimum of three examiners. The goal of this analysis is to check for relevancy between the definition and items on the instrument, clarity, and how representative the items are of the content domain.

To establish content validity experts were asked to analyze each survey item on the instrument for their relevancy to the given definition. Using a rubric developed by the researcher (Appendix H), panelists were instructed to put a “check” in the column marked “Inappropriate” if it did not align with the definition. The scores from the evaluators were analyzed using a content validity index (CVI).

Lynn's (1986) criteria for using 3 experts require a CVI score of 1.00 meaning that all of the experts should agree on the item analysis. A CVI was calculated on the content. If the CVI was 1.00 for every item the instrument would be deemed content valid. If not, the items that were selected as "inappropriate" were sent back to the expert panel for review. Suggestions were solicited for refining the survey item to make it appropriate and this process was continued until the experts were in agreement that it was appropriate. Content Validity was established when consensus reached the 1.00 level. This meant that there was a unanimous agreement that all the items or questions satisfied the given definition and the instrument was an adequate representation of the total domain of what is being measured. (Fraenkel and Wallen, 2003). This same process used to establish content validity was used for establishing construct validity.

Construct Validity. Construct validation is defined as the extent to which an assessment measures the concept or construct it aims to measure. It is necessary to help researchers establish and provide confidence that the survey items actually measure the constructs they propose to measure. It also allows researchers to draw legitimate conclusions from their findings. The process of establishing construct validity for any test should be an on-going effort in which "various sources of evidence are gathered, synthesized, and summarized" (Cizek, Rosenberg, & Koons, 2008, p. 298).

Construct validity of the PATT-ELEM, must be established to ensure its viability as an instrument for assessing elementary level student attitudes toward technology. The researcher used the same panel of experts as previously described to assist in determining if the modified instrument adequately measures constructs for the audience it is intended and review the PATT-

ELEM instrument for clarity as well as suggest any recommended changes. This concurrent analysis used the same procedures for establishing construct validity as those used in establishing content validity. The difference being that construct validity involves measuring the conceptual theory provided. In this case, the construct is technological literacy. Validation of content and construct resulted in a robust instrument ready to use with fifth grade students.

Phase 3: Establishing Instrument Readability

The purpose of Phase 3 was to determine the readability level of the PATT-ELEM instrument. Readability is the ease in which text can be read and understood. Before administering the PATT-ELEM instrument to elementary students, a readability level was calculated. Readability formulas analyze text and predict which reading materials can be comprehended and understood by certain readers. Kincaid, Fishburne, Rogers, and Chissom (1975) established that the Flesch-Kincaid Readability Formula is an accepted standard readability formula to be used by many United States Government agencies. The formula follows four steps. Step 1: Calculate the average number of words used per sentence, Step 2: Calculate the average number of syllables per word, Step 3: Multiply the average number of words by 0.39 and add it to the average number of syllables per word multiplied by 11.8, and Step 4: Subtract 15.59 from the result. The mathematical formula is $FKRA = (0.39 \times ASL) + (11.8 \times ASW) – 15.59$. Using this formula the researcher determined the readability level of the PATT-ELEM instrument, which is reported in the results section.

After determining that the PATT-ELEM instrument contained appropriate technological terminology, was both content and construct valid, and was at an appropriate fifth grade reading level, the instrument was prepared for administration via computers by converting the survey items into a digital format using Qualtrics online survey software provided by Virginia Tech.

Students attending elementary schools in Virginia are accustomed to taking computerized standardized tests frequently throughout the school year. The electronic version of the PATT-ELEM instrument is similar in format to end of grade standardized assessments where students click on a response and click “next” to progress to the next question. The electronic, online PATT-ELEM survey was formatted in such a way that only one question appears at a time.

The display format of the survey was regarded as significant as well. “The visual presentation of information to the interviewer, as well as the design of auxiliary functions used by the interviewer in computer-assisted interviewing, are critical to creating effective instruments” (Presser et al., 2004, p.121). Therefore, careful attention, such as fonts and layout, was given to make the instrument appealing to fifth grade students.

Data Collection Procedures

Data collection took place two weeks in the middle of May 2015 at the elementary school selected for this study. A sample size of 100 students was targeted. The participation invitation letter was sent to all fifth grade students two weeks prior to the testing cycle. Parents and students were asked to reply with consent by returning a completed and signed permission form within two weeks in order to be able to participate.

PATT-ELEM Administration

Fifth grade students from five different classes participated in this study over the course of four weeks. All fifth grade classes have regularly scheduled forty-five minute computer lab sessions. The PATT-ELEM was administered to each class of fifth graders during two, consecutive 45-minute computer-lab sessions. In each consecutive computer-lab session students were instructed by the researcher to complete one half of the survey per session, each of which consisted of 50 questions.

In each session the researcher followed a script (Appendix I) to introduce and administer the survey. The procedures for administering the survey follow:

1. As students arrived to the testing site they were given a card with their name and identifying code. At the first session the purpose of the survey was explained to participating students. The researcher told students how many questions there were, that the survey should take no more than 45 minutes, and that questions would appear in a multiple-choice fashion. It was explained that every question needed an answer before proceeding to the next question.
2. Students were told to click on the appropriate link that directed them to the survey.
3. Students were told to locate their unique, identification code on their card. It was explained that in order to log in to the testing portal the code needed to be typed correctly. Students were asked to type their code into the box that was designated "Log In." Students were told when they hit "Return" on the keyboard it allowed them to access entry into the survey.
4. Once students were logged in on their computer the administrator read through the directions listed at the beginning of the survey on the computer. To acquaint student with answering survey questions a sample survey question was presented to students. Before students were to answer the sample question the researcher explained that answer choices would be a range of possible responses. Students were asked to respond to the sample question on the computer by clicking on the one of the answer responses. The researcher asked if there were questions about what they were to do and responded to questions asked.

5. Students began the survey. The researcher assisted students in logging out of the survey, if necessary. Once students were finished they were instructed to proceed with what their regular classroom teacher had assigned. Students were also reminded that they would finish the survey at their next visit to the computer lab.

Results of the PATT-ELEM survey were collected through Qualtrics from Virginia Tech. Responses were compiled into a single data set.

Data Analysis

In order to answer stated Research Question 1 (Sub-Q1through Sub-Q4) an analysis of quantitative data was performed by the researcher. Data from the PATT-ELEM were collected through Qualtrics and transferred directly into SPSS (Statistical Package for the Social Sciences) for analysis by the researcher. All data were recorded and reported using unique codes assigned to students. These codes could not be identified directly or through identifiers linked to the subjects.

Research Question 1, inclusive of Sub-Q1 through Sub-Q3, was answered prior to administration of the survey. In order to answer Research Question 2, the following analysis was performed. Using SPSS an examination of this survey included:

1. Frequency analysis of all measured variables to determine number of occurrences as well as central tendencies.
2. Factor analysis of the attitude items for data reduction and to identify the nature of constructs underlying responses.
3. Reliability analysis of the attitudes and concept items using Cronbach's alpha coefficient for homogeneity on the attitude scale and the Kuder-Richardson Formula 20 (KR-20) on the concept scale.

Phase 4: Establishing Reliability

The purpose of the final phase, Phase 4, was to establish reliability of the PATT-ELEM instrument. Reliability involves consistency in experiments, test, or measuring procedures. Joppe (2000) defines reliability as:

> …the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. (p. 1)

Fraenkel and Wallen (2003) state that one method of establishing reliability is through measuring internal-consistency. The Kuder-Richardson approach is often used and requires the following three pieces of information (a) the number of items on the test, (b) the mean, and (c) the standard deviation. According to Nunnally (1978) a suggested coefficient alpha score should be at or above .70. Using this formula to calculate a Cronbach alpha score of at least .70 or higher indicates strong reliability in the PATT-ELEM survey.

Cronbach's alpha, a statistic calculated from the correlations between items also known as a correlation coefficient, is used for analyzing survey items for internal consistency. Surveys that elicit the same results over time indicate strong reliability. The standard formula for calculating Cronbach's alpha is:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

The PATT ELEM reliability analysis was carried out using Cronbach's α (Cronbach, 1950) to assess the validity of these scales. An explorative factor analysis (EFA) was conducted on the data collected from administration of the PATT-ELEM to fifth grade students. Values of α at or in excess of 0.70 indicate that given the exploratory nature of the analysis, the scales can be considered reliable (Nunnally, 1978).

Sub-Q4 was answered according to reliability test run from data collection. The results are provided in the succeeding chapter.

CHAPTER FOUR:

DATA ANALYSIS AND FINDINGS

The purpose of this study was to develop and validate an instrument to assess elementary students' attitudes toward technology, specifically fifth graders. The researcher modified a previously reliable and valid attitudinal scale designed for middle and high school students for use with elementary students, established the validity and reliability of the modified instrument, and then piloted the instrument as a preliminary assessment of elementary students' attitudes toward technology. This chapter presents the analysis of data used in establishing instrument validity and reliability as well as data collected through the administration of the modified instrument as a preliminary assessment of fifth grade student attitudes toward technology.

Using the original PATT-USA instrument, modifications to outdated terminology were made by experts and reviewed by an expert panel. Through this interrater process problematic words on the instrument were made current. The resultant instrument was renamed the PATT-ELEM and analyzed to establish acceptable levels of content and construct validity. The framework of this research followed a non-experimental descriptive research design that involved a one-time interaction with a convenient population of fifth grade students. Data were collected and then analyzed in response to the following research questions:

RQ1. To what extent is a modified PATT Instrument (PATT-ELEM) a valid tool to assess fifth grade students' attitudes toward technology?

Sub-Q1: What level of content validity can be established in measuring fifth grade attitudes toward technology?

Sub-Q2: What level of construct validity can be established in measuring fifth grade attitudes toward technology?

Sub-Q3: How suitable is the readability level of the PATT-ELEM instrument for fifth grade students?

Sub-Q4: What level of reliability can be established in measuring fifth grade attitudes toward technology?

RQ2. What are fifth grade students' attitudes toward technology?

Data collection and analysis addressing RQ1 was organized into four distinct phases. Phase 1, Correction of Terminology, engaged a panel of experts in a procedure necessary to modify problematic terminology of the original instrument. Phase 2, Content and Construct Analysis Procedures, involved the same group of interraters for correcting terminology to establish instrument content and construct validity as modified in Phase 1. This process of establishing interrater reliability and level of consensus was applied in determining both content and construct validity. Establishing the instrument's readability level occurred in Phase 3, Establishing Instrument Readability. Phase 4, Establishing Reliability, involved preliminary testing of the modified instrument to determine whether or not it could be considered a reliable instrument for assessing attitudes toward technology among fifth grade (elementary) students. Data collection and analysis addressing RQ2 was organized around a preliminary factor analysis of items and subsequent analysis of results from administration of the PATT-ELEM with a convenience sample of fifth grade students to determine their attitudes toward technology.

This chapter presents the findings first for RQ1 and Sub-Qs in the following order: Phase 1: instrument modification, Phase 2: instrument validity, Phase 3: instrument readability, and Phase 4: instrument reliability. These findings are followed by presentation of findings for RQ2 in the following order: frequency analysis and factor analysis.

Phase 1: Correction of Terminology

Correction of Terminology. Experts reviewed the original PATT instrument and found seven items that contained questionable terminology, mostly due to the age of the instrument. Through email correspondence three interraters reviewed highlighted words in the seven items and were asked to evaluate whether the word(s) were (a) current and did not need modification or (b) outdated and did need modification. If they felt a modification was needed, they were asked to provide a replacement word or words that would provide better understanding for the item(s) while keeping the same meaning as the original item. Table 2 shows the items presented to the panel, their responses for modification and the modifications they suggested.

Table 2.

Results of Reviewing Problematic Terminology Within Items

Item #	Statement Portion Under Review	Reviewer #	Modification Needed Y	Modification Needed N	Suggested Change
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?	Rater 1 Rater 2 Rater 3	√ √ √		1:Remove Tinkertoy-Add K'NEX 2: A smart phone, a gaming system, or radio controlled vehicles 3: K'NEX, LEGO, or MagnaBlox
7	Is there a technical workshop in your home?	Rater 1 Rater 2 Rater 3	√ √	 √	1: Omit question 2: Are there technical tools available…
11	Are you taking or have you taken Technology Education/Industrial Arts?	Rater 1 Rater 2 Rater 3	√ √ √		1: Remove Industrial Arts-consider Career and Technical Education Courses 2: Any classes where you learn about the processes and knowledge related to technology 3: Any Technology Education classes?
23	I like to read technological magazines.	Rater 1 Rater 2 Rater 3	√ √ √		1: Restate as technology magazines 2: Print and online magazines about technology 3: Technical magazines
29	There should be less TV and radio programs about technology.	Rater 1 Rater 2 Rater 3	√ √	 √	1: Omit radio programs 2: Internet information and videos
40	I think working in a factory is boring.	Rater 1 Rater 2 Rater 3	 √	√ √	2: Manufacturing plant
59	Girls prefer not to go to a technical school.	Rater 1 Rater 2 Rater 3	√ √	 √	1: Change to "not to study technology" 2: Career and technical

Agreement was not reached on all items needing modification. Table 3 shows the levels of agreement for this step of terminology correction. There was 100% agreement among all raters that items 6, 11, and 23 were in need of modification. Rater 2 felt that all items needed modification but rater 3 felt that items 7, 29, 40, and 59 did not need modifications. Items 29 and 59 had 66% consensus that the item did not need modification. The only item that had 33% in favor of no modification, by rater 1, was item 40.

Table 3.

Table of Consensus for Correction of Terminology

	Raters				
Item	1	2	3	#/3	% Agreement
6	1	1	1	3/3	100
7	1	1	0	2/3	66
11	1	1	1	3/3	100
23	1	1	1	3/3	100
29	1	1	0	2/3	66
40	0	1	0	1/3	33
59	1	1	0	2/3	66

Note: 1 indicates acceptance, 0 indicates rejection

Since the agreement varied from 33% to 100%, the researcher synthesized the responses provided by the panel and compiled a modified set of items to be evaluated by the panel. In an effort to keep the item concise but still inclusive of the suggestions made by each rater, the researcher took at least one suggestion from every rater that responded and crafted a modified item. A recast of modified terminology was sent back to the panel for review. Table 4 displays the problematic items, original suggested modifications, and new statements inclusive of suggestions by raters.

Table 4.

Modification of Terminology Process

Item #	Statement Portion Under Review	Suggested Changes By Rater	Final Modified Item
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?	1:Remove Tinkertoy-Add K'NEX 2: A smart phone, a gaming system, or radio controlled vehicles 3: K'NEX, LEGO, or MagnaBlox	Do you have technical toys, like LEGOs, K'NEX, MagnaBlox, or Smartphones at home?
7	Is there a technical workshop in your home?	1: Omit question 2: Are there technical tools available…	Are there technical tools available in your home?
11	Are you taking or have you taken Technology Education/Industrial Arts?	1: Remove Industrial Arts-consider Career and Technical Education courses 2: Any classes where you learn about the processes and knowledge related to technology 3: Any Technology Education classes?	Are you taking or have you taken Technology Education classes where you learn processes and systems?
23	I like to read technological magazines.	1: Restate as technology magazines 2: Print and online magazines about technology 3: Technical magazines	I like to read technology or technical magazines.
29	There should be less TV and radio programs about technology.	1: Omit radio programs 2: Internet information and videos	There should be less TV or Internet information about technology.
40	I think working in a factory is boring.	2:Manufacturing plant	I think working in a factory or manufacturing plant is boring.
59	Girls prefer not to go to a technical school.	1: Change to "not to study technology" 2: Career and technical	Girls prefer not to study technology or go to a career and technical school.

Note: Red words under "Original Item" are problematic words.
Blue words under "Modification of Item" show changes made from suggestions.

Interrater Reliability. To determine interrater reliability for items of an instrument, the Fleiss' kappa (Fleiss, 1971) has been found to be an accepted method used for any number of raters when giving categorical ratings to a fixed number of items. Agreement is when a fixed number of people assign the same numerical ratings to a number of items. This study attempted to establish interrater reliability using Fleiss' kappa for agreement among three raters regarding each of the seven problematic items that would be included on the modified PATT-ELEM instrument. Table 6 displays the results of the Fleiss' kappa analysis and shows that all three interraters agreed 100% to the researcher's suggested change of wording for the PATT-ELEM instrument.

Table 5.

PATT-ELEM Terminology Interrater Reliability Established Among Raters

	Raters				
Item	1	2	3	*k*	% Agreement
6	1	1	1	1	100
7	1	1	1	1	100
11	1	1	1	1	100
23	1	1	1	1	100
29	1	1	1	1	100
40	1	1	1	1	100
59	1	1	1	1	100

Note: 1 indicates acceptance, 0 indicates rejection

Landis and Koch (1977) suggest that kappa-statistic measure of agreement between .81 – 1.00 represents almost perfect-to-perfect agreement. Fleiss (1977) defines this same measure of agreement, 100%, as excellent. The overall kappa resulted in $\kappa = 1$ which represents a perfect level of agreement as shown in Table 6.

Table 6.

Interrater Reliability Kappa

Items	Acceptance	Rejection	Agreement P_i
1	3	0	1.0
2	3	0	1.0
3	3	0	1.0
4	3	0	1.0
5	3	0	1.0
6	3	0	1.0
7	3	0	1.0
Total	21	0	1.0
p_j	1	0	7.0

Notes: Minimum score = 0 (Do not accept), Maximum score = 1 (Accept)

The formula and calculations are:

$$\kappa = \frac{\bar{P} - \bar{P}_e}{1 - \bar{P}_e}$$

$$P_1 = \frac{3+3+3+3+3+3+3}{21} = 1$$

$$\bar{P} = \frac{1}{(7)} (7) = 1$$

$$\bar{P}_e = 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 = 1$$

If the raters are in complete agreement then $k = 1$.

Phase 2: Content and Construct Analysis Procedures

Research Question 1. Research question one (RQ-1), “To what extent is a modified PATT Instrument (PATT-ELEM) a valid tool to assess fifth grade students’ attitudes toward technology?” contained three sub-questions (SubQ-1, SubQ-2, and SubQ-3). Phase 2 addressed SubQ-1: What level of content validity can be established in measuring fifth grade attitudes toward technology? It also addressed SubQ-2: What level of construct validity can be established in measuring fifth grade attitudes toward technology? The goal of this phase was to establish content and construct validity of the PATT-ELEM and involved the same panel of experts that was used for correcting the terminology.

Content Validity. Given the operational definition of technological literacy, the three interraters analyzed all 89 survey item of the modified PATT-ELEM instrument for content validity. This group of experts evaluated items 12-69 on attitudes and items 70-100 on concepts and provided a score on how well the wording of each item adequately represented the content of technological literacy. Items 1-11 were excluded because they were request for demographic information that did not relate to attitudes toward technology. Using a reviewer rubric developed by the researcher, panelists were asked to put a “check” in the column marked “Appropriate” or “Inappropriate” for alignment with the definition of technological literacy (Appendix J). This group of experts evaluated each item and indicated, by placing a check in the appropriate or inappropriate column, that the wording of each item either did or did not adequately represent the content of technological literacy. The mean was calculated for each item on the PATT-ELEM instrument to determine the degree of consensus among the three interraters (Table 7). Results indicated there was 100% agreement among panelists that all items satisfied the operational definition of technology and were therefore valid items addressing technology content.

Table 7.

Interrater Evaluation for Content Validity

		Raters			
Items	1	2	3	Number in agreement	% Agree
12-69 (Attitude items)	1	1	1	3	100
70-100 (Concept items)	1	1	1	3	100

1 indicated acceptance that content was reflective of operational definition
0 indicated rejection that content was reflective of operational definition

Construct Validity. Construct validation is defined as the extent to which an assessment measures the construct it aims to measure. Using a reviewer rubric developed by the researcher and the same technological literacy definition as described in the content validation, panelists reviewed the PATT-ELEM instrument for how well each item aligned with the construct it aimed to measure (Appendix K).

The mean was calculated for agreement on each item on the PATT-ELEM instrument to determine the degree of consensus among the three interraters (Table 8). Results indicated 100% agreement among panelists that all items satisfied both the operational definition and the construct for technology and were therefore valid items addressing the construct of technology.

Table 8.

Interrater Evaluation for Construct Validity

	Raters				
Items	1	2	3	Number in agreement	% Agree
12-69 (Attitude items)	1	1	1	3	100
70-100 (Concept items)	1	1	1	3	100

1 indicated acceptance that content was reflective of operational definition
0 indicated rejection that content was reflective of operational definition

Phase 3: Establishing Instrument Readability

The purpose of Phase 3 was to address the readability level of the PATT-ELEM instrument, focusing on SubQ-3 of this study. Kincaid, Fishburne, Rogers, and Chissom's (1975) Flesch-Kincaid Readability Formula, an accepted standard readability formula to be used by many United States Government agencies, was the method of analysis employed to establish the readability level of the PATT-ELEM. Reports from this analysis are reported in Table 10.

The Flesch-Kincaid Readability Formula encompasses six categories of measurement. The first category, the Flesch Reading Ease score, measures textual difficulty, which indicates how easy a text is to read. Score ranges between “90-100” are easily understood by average 11 year-old students (fifth grade students). A score of 60-70 is easily understood by 13-15 year old students (seventh to ninth grade students). The second category is the Flesch-Kincaid Grade Level score. It is based on the number of years of education in the United States that is generally required to understand this text. The third category gauges the understandability of a text and grade level understandability and is what the Coleman-Liau index provides. The SMOG Index, the fourth category, estimates the years of education a person needs to understand a piece of writing. The fifth category, the Automated Readability Index score, is another readability measure designed to gauge the understandability of text and is an approximate representation of the United States' grade level needed to comprehend the text. Last, the Linear Write Formula is based on sentence length and the number of words with three or more syllables. It gives a grade equivalent true to the United States grade level system. Table 9 shows readability results.

Table 9.

Flesch-Kincaid Readability Results

Measure	Rating
Flesch Reading Ease score	57.9 (7th grade)
Flesch-Kincaid Grade Level	7.5 grade
The Coleman-Liau Index	10th grade
The SMOG Index	7.8 grade
Automated Readability Index	5.7 (10-11 year olds)
Linear Write Formula	5.5 (10-11 year olds)

Based on the results of this assessment, the findings indicate that only two categories out of six actually fell in the range of the fifth grade students who took this survey. The PATT-ELEM instrument readability level, overall, was appropriate for a higher grade-level than those who participated in this study. These scores (Table 9) indicated that the text used for the items of the PATT-ELEM was at a reading level too difficult for the fifth grade students who took the survey. However, two scores, the Automated Readability Index and the Linear Write Formula, indicated that the PATT-ELEM instrument did fall into a fifth grade range.

Phase 4: Establishing Reliability – Administration of PATT-ELEM

Sub-Question 4. Sub-Question 4 asks, **"**What level of reliability can be established in measuring fifth grade attitudes toward technology?"

One hundred invitations were sent to all fifth grade students at the elementary school where data collection occurred. Ninety-one percent returned the invitation to participate.

Statistical procedures using the Statistical Program for the Social Sciences were used to analyze responses to the PATT-ELEM survey and the semantic differential to measure attitudes and perceptions.

Items 1-11 gathered demographic data about each student and information about the technological climate of students' homes. PATT-ELEM items 12-69 assessed student attitudes and items 70-100 assessed students' concepts.

For the attitude section of the PATT-ELEM, the following statistical procedures were computed: (a) factor analysis, (b) varimax rotation, (c) reliabilities, and (d) principal component analysis. For the concept section of the PATT-ELEM the same statistical procedures were followed.

Demographic Data

The demographic data for the participants collected in this study is presented in the following order: gender and age data, experience with technology tools, and family involvement with technological fields. Information about the participant's age, gender, and grade level were collected from survey items 1–3. Items 4–8 asked the participants to assess the technological climate in their homes. The perception of their parents' jobs, availability of technical toys and technical workshops in their homes, and presence of computers in their homes were the focus of these questions. Items 9-11 dealt with whether participants would choose technological professions, the impact of siblings having technological jobs, and whether the participants were currently taking a Technology Education class. Table 10 summarizes the gender and age data about the participants.

Table 10.

Summary of Participants' Gender and Age Demographics

Gender n (%)		Age n (%)
Male	41(45)	10 (36)
Female	50(55)	11 (57)
		12 (1)

There was a balanced representation of gender (boys and girls) among the participants taking the survey. A majority of the participants taking the survey were 11 years old, which is the normal age of a fifth grader. Table 11 presents demographic data about the technological climate in students' homes and about how their parent's occupations are related to technology.

Table 11.

Summary of Participant's Perceptions of Technological Nature of Parent's Jobs

	Very Much n (%)	Much n (%)	Little n (%)	Nothing n (%)
If your father has a job, indicate to what extent it has to do with technology.	18 (20)	23 (25)	40 (44)	10 (11)
If our mother has a job, indicate to what extent it has to do with technology.	15 (16)	20 (22)	36 (40)	20 (22)

Table 12 displays the data collected concerning the use of technological toys and electronics in the home.

Table 12.

Summary of Participants' Use of Technological Toys and Electronics Demographics

	Yes (%)	No (%)
Do you have technical toys like LEGOs, K'Nex, MagnaBlock, or Smartphones at home?	91 (100)	0 (0)
Are there technical tools available in your home?	88 (97)	3 (3)
Is there a personal computer in your home?	76 (84)	15 (16)
Do you think you will choose a technological profession?	50 (55)	41 (45)
Do you have brothers or sisters that have a technological profession or that are studying for it?	15 (16)	76 (84)
Are you taking or have you taken Technology Education classes where you learn processes and system?	25 (27)	66 (73)

Reliability. Surveys that elicit the same results over time indicate strong reliability. Internal consistency reliability estimates for each subscale resulting from the principal component analysis of the PATT-ELEM responses were calculated. This was also performed in the original PATT-USA study.

The following chart explains how a Cronbach's Alpha score is interpreted.

Cronbach's alpha	**Internal consistency**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Results from the reliability estimates, Cronbach's Alpha, for the PATT-ELEM attitude section, items 13-69, and the concept items, items 70-100, are shown in Table 13.

Table 13.

Internal Consistency Reliability (Cronbach's Alpha)

Variable	N of items	N	Cronbach's Alpha
Attitude	58	91	.49
Concept	31	91	.77

Reliability estimates for the attitude section of this instrument resulted in a low Cronbach Alpha score of .49. This fell in the unacceptable range of internal consistency indicating that the items could be inappropriate for assessing technological literacy with this age group. However, the reliability estimates in the concept section generated a Cronbach's Alpha score of .77, which indicated acceptable internal consistencies. A score ranging between .7 and .9 is good and values of α at or in excess of 0.70 indicate that, given the exploratory nature of the analysis, the scales can be considered acceptable and reliable (Nunnally, 1978).

Research Question 2. Research Question 2 asks, "What are fifth grade students' attitudes toward technology?

Principal Component Analysis. A principal component analysis was computed on the PATT-ELEM for all 91 subjects identifying underlying variables, or components, to explain the pattern of correlations among the responses to the survey items. The original PATT-USA instrument was scaled into six factors. The data collection procedures followed in this research endeavored to replicate the same reporting of data from the original PATT-USA data analysis. Bame and Dugger (1989) reported that six principal components factor analyses with Varimax rotations were computed: five on the attitude items (13-69) and one on the concept items (70-100). The five factors reported in the original study were (1) General Interest in Technology, (2) Attitudes Toward Technology, (3) Technology as an Activity for Both Girls and Boys, (4) Consequences of Technology, and (5) Technology is Difficult. The principal components factor analysis on the concept items (70–100) resulted in two factors.

The factors established in the original version of the PATT instrument closely aligned with the factors established from the principal components analysis of this study. In order to meet the statistical requirements of running factor analysis two tests were carried out to measure sample adequacy. These tests were Kaiser-Meyer-Olkin (KMO) and Bartlett's test of Sphericity. The Kaiser-Meyer-Olkin index of sampling adequacy was .543 for the sample, indicating that the data represented a homogeneous collection of variables that were suitable for factor analysis. Kaiser (1974) recommends recognizing values greater than 0.5 as acceptable. More specifically, values between 0.5 and 0.7 are considered mediocre, values between 0.7 and 0.8 are considered good, values between 0.8 and 0.9 are deemed great and values above 0.9 are superb (Hutcheson and Sofroniou, 1999). Bartlett's Test of Sphericity was significant for the sample [χ^2 (1653) =

2852.753; p <.0001], indicating that the set of correlations in the correlation matrix was significantly different from zero and suitable for factor analysis. A small p value indicates that it is highly unlikely to have obtained the observed correlation matrix from a population with zero correlation. Table 14 displays those findings.

Table 14.
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.543
Bartlett's Test of Sphericity Approx. Chi-Square		2852.753
	df	1653
	Sig.	.000

A Varimax rotation analysis simplified scaling of the factor loadings. The results of the rotation created patterns within the factors. Factor loadings of .3 or higher were used for this analysis. A Rotated Component Matrix displays the loadings for each item on each rotated component, again clearly showing which items make up each component. As a result, the Component Transformation Matrix table (Table 15) reveals the correlations among the components following the rotation. This rotation converged into 6 components, which is similar to how the factors loaded in the original PATT-USA study.

In order to validate the groups of the attitude scale and to reduce the 58 attitude items into meaningful scales, principal component factor analyses with varimax rotations were computed on the attitude items (Items 12-69). The results of the factor analysis yielded the following five attitudinal factors, (1) General Interest in Technology, (2) Attitudes Towards Technology, (3) Technology as an Activity for Both Girls and Boys, (4) Consequences of Technology, and (5) Technology is Difficult. The high loading items for each factor are outline below.

1. General Interest in Technology
    - 12. When something new is discovered, I want to know more about it immediately.
    - 17. Technology is good for the future of this country.
    - 18. I would like to know more about computers.
    - 22. I would not like to learn more about technology at school.
    - 23. I like to read technology or technical magazines.
    - 28. I will not consider a job in technology.
    - 29. There should be less TV or Internet information about technology.
    - 32. I would rather not have technology lessons at school.
    - 33. I do not understand why anyone would want a job in technology.
    - 34. If there were a school club about technology I would certainly join it.
    - 38. Technology at home is something schools should teach about.
    - 39. I would enjoy a job in technology.
    - 44. I should be able to take technology as a school subject.
    - 45. I would like a career in technology later on.
    - 46. I am not interested in technology.
    - 48. Using technology makes a country less prosperous.
    - 50. There should be more education about technology
2. Attitude Toward Technology
    - 51. Working in technology would be boring.
    - 52. I enjoy repairing things at home.
    - 53. More girls should work in technology.
    - 54. Technology causes large unemployment.

- 56. Technology as a subject should be taken by all pupils.
- 57. Most jobs in technology are boring.
- 58. I think machines are boring.
- 60. Because technology causes pollution, we should use less of it.
- 62. Technology lessons help to train you for a good job.
- 63. Working in technology would be interesting.
- 64. A technological hobby is boring.
- 66. Technology is the subject of the future.
- 68. Not everyone needs technological lessons at school.
- 69. With a technological job your future is promised.

3. Technology as an Activity for Both Girls and Boys

- 19. A girl can very well have a technological job.
- 21. You have to be smart to study technology.
- 24. A girl can become a car mechanic.
- 26. Technology is only for smart people.
- 30. Boys are able to do practical things better than girls.
- 35. Girls are able to operate a computer.
- 37. You have to be strong for most technological jobs.
- 41. Boys know more about technology than girls do.
- 43. To study technology you have to be talented.
- 47. Boys are more capable of doing technological jobs than girls.
- 49. You can study technology only when you are good at mathematics and science.

4. Consequences of Technology

- 14. Technology is good for the future of this country.
- 15. To understand something of technology you have to take a difficult training course.
- 16. At school you hear a lot about technology.
- 20. Technology makes everything work better.
- 25. Technology is very important in life.
- 27. Technology lessons are important.
- 31. Everyone needs technology.
- 36. Technology has brought more good things than bad.
- 42. The world would be a better place without technology.

5. Technology is Difficult

- 59. Girls prefer not to study technology or go to a career and technical school.
- 61. Everybody can study technology.
- 65. Girls think technology is boring.
- 67. Everyone can have a technological job.

The following three attitude items did not load on the factor analysis.

- 13. Technology is as difficult for boys as it is for girls
- 40. I think working in a factory or manufacturing plant is boring
- 55. Technology does not need a lot of mathematics.

To determine if there were gender differences in pupils' attitudes toward technology, a *t*-test was conducted for every item. Ten items were found to have significant differences in attitudes based on gender (Table 15). A complete listing of all results of all PATT-ELEM *p*-values and analysis of variances may be viewed in Appendix L.

Table 15.

Mean Scores and Standard Deviation for Gender Differences

Factor Area and Survey Items	Male (n = 41)		Female (n = 50)		
	Mean	SD	Mean	SD	*p*-value
General Interest in Technology					
34. If there were a school club about technology I would certainly join it.	2.13	1.105	2.84	1.315	**.028**
39. I would enjoy a job in technology.	2.13	1.196	2.86	1.212	**.016**
45. I would like a career in technology later on.	2.21	1.321	3.02	1.237	**.017**
46. I am not interested in technology.	4.26	1.093	3.52	1.374	**.017**
Attitude Toward Technology					
52. I enjoy repairing things at home.	1.90	1.046	2.44	1.312	**.028**
58. I think machines are boring.	4.44	.940	3.84	1.267	**.013**
Technology as an Activity for Both Girls and Boys					
30. Boys are able to do practical things better than girls.	3.90	1.119	4.66	.823	**.000**
41. Boys know more about technology than girls do.	4.28	.972	4.74	.664	**.004**
47. Boys are more capable of doing technological jobs than girls.	4.23	1.087	4.60	.728	**.028**
Consequences of Technology					
14. Technology is good for the future of this country.	1.77	1.087	2.36	1.005	**.015**

There were significant differences in responses between girls and boys in four out of five attitude factor areas. There were no significant differences on the “Technology is Difficult“ attitude subscale or any of the concept subscales. To closely examine the power of these differences Table 16 shows how significant those differences were. Two out of four factor areas, General Interest in Technology and Technology as an Activity for Both Girls and Boys, both resulted in strong percentages of gender differences. Four out of seventeen items or 23% of all the items in the General Interest in Technology factor area revealed that boys and girls have strong attitudinal differences. Even stronger, the Technology as an Activity for Both Girls and Boys subscale had statistically significant difference of 27%. Three out of eleven items, nearly one third of this group of survey takers, showed a statistically significant variance on those items.

Table 16.

Significant Gender Differences by Factors

Attitude Subscale	N/Total Items	%
Technology as an Activity for Both Girls and Boys	3/11	27
General Interest in Technology	4/17	23
Attitude Toward Technology	2/14	14
Consequences of Technology	1/9	11

Qualitative Assessment. The first item on the survey asked for a written response from participants to the following open-ended item, "Please give a short description of what you think technology is." From the responses of the participants two analyses were performed. First, the researcher organized the data from this qualitative response into a frequency count of technology-related words that participants used in their responses. Next, the researcher organized these responses into categories that ranged from abstract to conceptual to concrete. A discussion of each method follows.

For the first process the researcher listed key words from the student responses and kept a tally of how many times the same or similar word(s) appeared. The researcher then organized the words into similar groupings, i.e. a devices group rather than singularly using a device name like iPads or iPods. The following table, Table 17, notes the answers provided by those students as categorized by the researcher.

Table 17.

Technology Related Words from Participant's Responses

Response	Frequency of response
Devices: Smartphone, iPod, iPad, etc.	28
Electricity or electronic	28
Computer	20
Something that helps you, new way of doing things, something that makes life easier, helps learning	18
Wifi, internet, etc.	12
Information, communication	9
Machines	8
Tools	3
Manmade	2

Next, the researcher organized the responses from participants into categories ranging from to concrete to conceptual to abstract. These responses, analyzed by the researcher, were placed in the corresponding category: abstract, conceptual, concrete, or multi-category. By defining what each category represents it was possible to organize the responses.

Category	**Definition**
Abstract	Answer included statements that were difficult to understand, reflected an attitude or view, apart from concrete existence
Conceptual	Answer included ideals about how technology improved a way of living, increased learning, involved the use of tools to create, and provided information.
Concrete	Answer included the description of a piece of hardware such as a computer, electronic device, or search engine

Responses were organized into categories and the results are shown in Table 20. Some participant's responses qualified for more than one category because they included more than one categorical response. One student's response contained all three categories. Most of the participants' responses were considered to be in the concrete category. The conceptual category was the second highest category, while the abstract category was the lowest. Table 18 shows the frequency of their responses.

Table 18.

Cumulative Qualitative Student Responses by Categories

	Abstract	Conceptual	Concrete	Abstract/ Conceptual	Abstract/ Concrete	Conceptual /Concrete	All
Frequency of Student Responses	9	40	61	2	0	13	1

A listing of all responses given by students can be viewed in Appendix M.

Summary of the Findings

Findings from analysis of data collected from this online survey developed for fifth grade students was presented in Chapter 4 to answer RQ1, inclusive of Sub-Q1 through Sub-Q4, and RQ2. The analysis provided instrument validation using interraters and reliability using Cronbach's Alpha and a principal components analysis. The credibility of the PATT-ELEM instrument used in this study, both quantitative and qualitative data, was based on data collected and analyzed.

Conclusions, implications, and recommendations drawn from these analyses are will be discussed in the following chapter.

CHAPTER FIVE:

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Chapter Five is organized around presentation of conclusions, implications, and recommendations for future research. Discussed first are conclusions derived from the interpretation of findings as presented in Chapter Four which were focused on answering the following two main research questions:

RQ1. To what extent is a modified PATT Instrument (PATT-ELEM) a valid tool to assess fifth grade students' attitudes toward technology?

RQ2. What are fifth grade students' attitudes toward technology?

Implications drawn from the conclusions are presented next, and the chapter ends by presenting a set of recommendations for future research.

Conclusions

The intent of this study was to develop an instrument that would provide a valid assessment of attitudes elementary students hold toward technology. The first part of the study was conducted in four phases, each designed to answer one of four sub-questions that collectively would be used in answering the first main research question. Phases 1 - 3 concentrated on preparing the instrument for administration and involved the correction of problematic terminology, content validation, construct validation, and a readability assessment as addressed by Sub-questions 1 – 3. Phase 4 entailed assessing the reliability of the PATT-ELEM instrument. The second part of the study involved conducting a pilot administration of the PATT-ELEM and analysis of results to determine the attitudes toward technology held by a unique sample of fifth grade students. Conclusions based on the analysis of findings from Phases

1 – 4 of the first part and the administration of the instrument in the second part of this research are discussed below.

RQ1: Instrument Modification Conclusions

Phase 1 Conclusions

This study used the original PATT-USA instrument as a starting point for developing the PATT-ELEM instrument. Since the age of the instrument was nearly thirty years old it was necessary to update some of the language of the instrument. The correction of problematic terminology process in Phase 1 required a strategic analysis by an expert panel. Interrater reliability regarding modified terminology resulted in a kappa-statistic of 1, perfect agreement, indicating the terminology within the PATT-ELEM instrument was now current.

Phase 2 Conclusions

Using the newly corrected PATT-ELEM instrument from Phase 1, the Phase 2 analysis of content and construct validity for every item of that instrument revealed 100% agreement that all items were in alignment with the operational definitions for technology and technological literacy.

Phase 3 Conclusions

Assessment of the readability level of the PATT-ELEM in Phase 3 using the Flesch-Kinkaid Readability Formula revealed that overall the instrument was at a reading level slightly too difficult for the intended audience. And though the difficulty was not so far above the 5th grade level (Table 10) as to be unreadable by participants, as constructed it does present a potential concern regarding the validity of results if administered in its current form.

Phase 4 Conclusions

Establishment of instrument reliability for assessing student attitudes toward technology was addressed by Sub-Q4, which asked: What level of reliability can be established in measuring fifth grade attitudes toward technology? This assessment required administration of the instrument to participating fifth grade students and analysis of the attitudinal items (13-69 and 70-100). Of the 100 participating fifth grade students, reflecting a fairly balanced gender ratio of mostly 11 year olds, a total of 91 usable responses were received. Based the findings, it can be concluded that the instrument is reliable regarding the internal consistency of the 31 concept items, but was unacceptable for internal consistency of the 58 attitude items.

Summary of Conclusions: Phases 1 – 4

As evidenced through results of data analysis in Phases 1 – 4 the modified PATT-ELEM instrument was determined to be valid for measuring elementary student attitudes toward technology, was at a readability level considered slightly above what is acceptable for fifth grade students, and only had acceptable internal consistency for the 31 concept items. Therefore, the overall conclusion that can be drawn from Phases 1 – 4 is that the PATT-ELEM instrument was marginally suitable for both administrating to fifth grade students and in ascertaining a valid reflection of the attitudes toward technology as held by the sample of fifth grade students.

RQ2: Attitudinal Conclusions

The second main research question was concerned with "What are fifth grade students' attitudes toward technology?" as revealed through administration of the PATT-ELEM instrument. The PATT-ELEM instrument is designed around four distinct sections each of which ask questions as described below and in the following order.

Section 1: comprised of a single open-ended question asking participants to describe what they think technology is,

Section 2: comprised of 11 questions (items 1-11) addressing student demographics,

Section 3: comprised of 57 questions (items 12-69) addressing the affective component of attitudes toward technology, and

Section 4: comprised of 31 questions (items 70-100) addressing the cognitive component of attitudes toward technology.

Discussed below are the conclusions reached based on the interpretation of findings from each of the four sections of the PATT-ELEM instrument.

Section 1 Conclusions: What is Technology?

The statement, “Please give a short description of what you think technology is”, which appeared on both, the original PATT-USA survey and the electronic PATT-ELEM survey required a written response. The researcher’s analysis of the responses was based on key words from what students said. Students tended to perceive that technology consisted of items that were electronic in nature rather than it being a process. Some students (18 out of the 91) stated that it was something that helps you, a new way of doing things, or something that makes life easier. This indicates that some students in this age group see technology as a process rather than an “item.” While this shows that technological thinking is somewhat present among elementary students, it is still is a long way from the goal stated in the Standards for Technological Literacy: Content for the Study of Technology (ITEA, 2000), which defines technological literacy as the “ability to use, manage, assess, and understand technology” (ITEA, 2000, p. 9).

To further understand how students responded to the open-ended question, the researcher evaluated the organized, raw data list to determine what students said. The cumulative, qualitative student responses in Table 20 indicated that a strong percentage of students thought technology was something concrete, such as a piece of hardware. What can be concluded from these responses is that, again, the students that took this survey believe that technology is strongly related to the electronic type of device. Based on these findings one would conclude that these students are unclear about the definition of technology.

Section 2 Conclusions: Student Demographics

Student responses to demographic items related to jobs held by their parents (Table 11) indicated that slightly more than half of them felt that both their fathers' (55%) and mothers' (62%) jobs had little or nothing to do with technology. A logical assumption would also be that if a parent did not have a job the student would have chosen the "nothing" category. Findings also revealed that slightly less than half of students felt that their fathers' (45%) and mothers' (38%) jobs had much or very much to do with technology. One would conclude that jobs held by either parent were roughly evenly split between those that were or were not related to technology.

Responses to demographic questions addressing the existence of technological objects in the home were, as might be expected, found to be notably different from the results of the original PATT-USA. Results from the PATT-ELEM showed that all students (100%) have technical toys like LEGOs, K'Nex, MagnaBlock, or Smartphone at home. Results also revealed that they have access to technical tools (97%) and that many students (84%) have a personal computer in their home. The conclusion reached is that technical toys are a common technology found in the homes of most every elementary level student.

The last set of demographic questions asked about choosing a technological profession, whether siblings were studying for technological professions, and if they were currently taking Technology Education classes. Their responses to choosing technological professions resulted in 55% “no” and 45% “yes.”

When asked if siblings were studying for technological professions, their response was 16% “yes” and 84% “no.” The participants’ response to taking Technology Education classes resulted with 27% “yes” and 73% “no.” Conclusions based on these findings are that a significant number of fifth grade students perceive technology-related jobs as likely future professions, even though most of their siblings were not going into a technology profession or they themselves were taking a Technology Education class.

Sections 3 & 4 Conclusions: Affective and Cognitive Attitudes

Interesting gender differences were revealed from *t*-tests. In four out of five factor areas significant gender differences were identified among items in these sections. The four factor areas that had differences were General Interest in Technology, Attitudes Toward Technology, Technology as an Activity for Both Girls and Boys, and Consequences of Technology. The subscale, Technology as an Activity for Both Girls and Boys, had the higher percentage gender difference at 27% following by subscale, General Interest in Technology, which had a 23% difference. More significantly, over one fourth of responses, 3 out of 11, from the subscale, Technology as an Activity for Both Girls and Boys, revealed a stronger disparity between boys’ and girls’ responses. According to this sampling of data it appears that this group of elementary students are diverse in thinking that technology activity is for both boys and girls Factor area, Technology is Difficult, did not have gender differences. This would indicate that both boys and girls, in this sampling, believe that technology is difficult.

Six items, Items 30, 39, 41, 45, 46, and 58, had significant *p*-values. Based on this information of students who took the PATT-ELEM survey, a discussion for each factor area follows.

Sub-scale area, Consequences of Technology, had only one item out of nine that resulted in a significant *p*-value. The item, “Technology is good for the future of this country.” was the only item that this group of elementary boys and girls differed on. This indicates that both elementary boys and girls, in this sampling, were fairly balanced in this view of technology.

On a slightly larger degree, sub-scale, Attitudes Toward Technology, had two items out of fourteen resulting in significant differences among this group of students. This implies that this group of boys and girls had some attitudinal differences in 11% of the items in this category. These results indicate that there are positive attitudes toward technology among this sampling but there are some gender differences between boys and girls.

Factor area, General Interest in Technology, resulted in a 23% difference. Four out of 17 items were found to be significant. This information concludes that there is a discrepancy between the perception of this group of boys and girls when it comes to items such as being interested in technology or boys knowing more about technological things than girls do. Three items, Item 34: “If there were a school club about technology I would certainly join it”, Item 52: “I enjoy repairing things at home”, and Item 47: “Boys are more capable of doing technological jobs than girls” all resulted in a slightly, higher *p*-value of .028. It would be expected that elementary students’ general interest in technology would not result this way due to the technology-rich environment they are exposed to. Today, young children experience technological toys and are exposed to modern, electronic devices than when the original PATT study was initiated but this does not assure they are attaining technological literacy.

More significantly, 27% of the items in sub-scale Technology as an Activity for Both Girls and Boys revealed a stronger difference between boys and girls in the perceptions of gender equality in technological activity. In previous PATT studies gender stereotypes were common. As per previous PATT research findings, there were differences in the perception of technology attributed to gender. This analysis suggest that the trend still exist among pupils, inclusive of this group of elementary children. This result indicates that male students still perceive that technology is more of an activity for both boys and girls than did female students.

With 10 items out of a total of 89 items resulting in a low *p*-value it can be concluded that this group of elementary students taking the PATT-ELEM survey, as stated in 11% of the responses, believe that boys are better, overall, at technological things than girls. There is clear evidence that girls lag in interest and participation of technological matters. This speaks to the importance of addressing gender bias in technology education curriculum.

Summary of Conclusions

RQ1 Conclusion

The overarching objective of this study was to develop an instrument that assesses elementary students' attitudes toward technology. Research Question 1, "To what extent is a modified PATT Instrument (PATT-ELEM) a valid tool to assess fifth grade students' attitudes toward technology?" with sub-questions was answered in the following discussion. To prepare the instrument for the research questions a correction of terminology, modified by a panel of expert, resulted in an updated instrument. Instrument content and construct validation was established by interraters, who agreed perfectly, ensuing Sub-Q1 and Sub-Q 2 were adequately answered. Sub-Q3, regarding readability, resulted in an instrument marginally suitable for fifth grade students. Reliability estimates of the PATT-ELEM, Sub-Q4, were answered by results that were divided. The attitude segment of the instrument fell in the unacceptable range in internal consistency. However, the concept section was found acceptable.

A culmination of these findings demonstrate that the PATT-ELEM instrument is functional with two considerations for improvement. Some adjustments to the readability level are imperative for adequately measuring the intended audiences' attitudes.   As well, the five factor areas that form the attitude section of the PATT-ELEM, needs modification to raise the reliability estimates. Reducing the number of redundant items to improve the alpha score should be considered for future investigations.

RQ2 Conclusion

Research Question 2 "What are fifth grade students' attitudes toward technology?" resulted in significant differences among gender in four out of five factor areas. It was expected that gender bias would not be as prevalent with the modern technological environment elementary students live but with this sampling of elementary students, gender difference still exist. Overall, the survey seems to be useful as instrument for measuring different aspects of attitudes towards technology.

Implications

The findings of this study have direct implications for the development of instruments to measure the level of technological literacy among students in elementary grades, and indirectly for Technology Education classroom practice. Those areas include instrument reliability, demographic questions, instrument readability, classroom practice, and gender issues.

Instrument Reliability

RQ2: Meaningful data collection is based on the effectiveness of the survey instrument. A high quality instrument is important in evaluating the reliability of data supplied by examinees. Reporting acceptable alpha values adds validity and accuracy to the integrity of an instrument. In this case there were varied results. The concept section was found acceptable but the attitude section was unacceptable. Alpha is affected by test length and dimensionality. With those thoughts in mind it is recommended that the concept section remain the same for future assessment since the alpha was satisfactory. However, the alpha for the attitude items needs improvement. Since there are five factors in the attitude section with many items per section, this could be a reason for the low score. A recommendation for increasing the alpha score would be to eliminate the items that did not load on the factor analysis.

Another recommendation in raising the alpha would be to analyze the attitudes items for redundancy. Some statements appear to be superfluous and are not necessarily needed. This instrument has 89 items, 58 that measure attitudes and 31 that measure concepts. It may be possible that fewer items could be used, especially on the 58 attitude items that resulted in an unacceptable alpha score of .49. Elimination of the redundant items would also make a shorter assessment. Overall, this might be better in using with younger students, especially if the PATT-ELEM is being considered for using with grades lower than fifth grade. This could result in an effective instrument to measure attitudes of a wider range of elementary age students. Ultimately, a higher alpha could evolve from these changes. The implication is that the PATT-ELEM instrument can be a tool for measuring elementary students' attitudes with some modifications.

Demographic Questions

Outcomes from several of the demographic items revealed unexpected results that have implications for determining the extent to which technology is a part of an elementary student's home life. It was expected that with the modern, technological environment these students live in that they would recognize the influence that technology has on society. The accumulation of technological knowledge does not necessarily translate to application of technological knowledge. Perhaps it is like not “seeing the forest for the trees” where student do not really know what technology is. As far as students’ views on what their siblings’ career paths are, there are assumptions to consider. Students who don’t understand what a technological job is may find it difficult to answer this question. As well, it is important to note the age of these students and their awareness of career paths. It would be recommended that either the item be rephrased so students could clearly understand the intent of the item or eliminating the item altogether.

Another item in the demographic section refers to their involvement in Technology Education classes. It was expected, with as much exposure this sampling has in Children’s Engineering, there would be a more positive response to this but once again, there may be a terminology issue with understanding what the definition of what a Technology Education class is or what it encompasses. In most elementary schools there is not a class called Technology Education. Therefore, they may not have an understanding of what that is. As mentioned in Chapter 1 (page 5) there are many students who are involved in Children’s Engineering classes or design engineering classes but they do not have the concept that this is Technology Education. A rephrasing of this question would be suggested to remove doubt and increase understandability in the purpose of this question.

The presence of computers is very common in American homes today. The researcher felt a point worth noting is that the wording of the question; “Is there a personal computer in your home?” may be misleading in the format in which the question was phrased. When students were taking the survey several asked if that meant they had their own personal computer, though the intent of the question was asking if there was a presence of a computer in the home rather than having their own computer. A change in how this question is stated would be a recommendation for the future to avoid misconceptions.

Readability

Knowing the reading level of text can give you a general idea of the audience who may be able to read it. For any survey to be effective and authentic the readers need to be able to read and understand the content. When students do not understand the questions the likelihood of “guessed” answers or randomly selected responses is higher.   Since the format of this electronic survey requires an answer to move to the next item, it is likely this could happen when the readability level is too advanced. The readability analysis performed on the PATT-ELEM revealed that the instrument was at a level slightly too difficult for fifth grade students. The language needs to be modified to lower the readability level for fifth grade students or younger. Another consideration would be to modify the language so that this instrument could be used to assess multiple elementary grades, possibly consisting of third, fourth, or fifth grades. The goal is to solicit genuine responses that reflect a true picture of what all elementary students think and feel about technology and acquiring appropriate readability levels are extremely important in attaining that information.

The suggestion of language modification, as previously stated, require re-evaluation of readability. Although the Flesch-Kinkaid was used for establishing readability levels in this study, there is evidence that it may not be reflecting the true 5th grade readability of the PATT-ELEM. Recent research (Benjamin, 2011) on analyzing readability levels has recognized that elementary students read varying types of reading materials; novels to technical writing to informational texts. Benjamin’s research suggests that the Dale-Chall Readability Formula works best, overall, in determining the readability of text for school children, grades 4 and above, who are "reading to learn" rather than "learning to read", as in emergent readers. Given the evidence from such research, for similar future studies, it is recommended that the PATT-ELEM instrument be re-evaluated using the Dale-Chall formula.

The PATT-ELEM instrument was designed specifically for fifth grade students. Assessment of elementary students' attitudes toward technology in grades lower than grade 5 would require the PATT-ELEM instrument to be significantly modified for appropriate grade-level administration and readability.

Classroom Practice and Gender Issues

The fifth grade population that participated in this survey have been involved in a school-wide Children's Engineering program for their entire elementary schooling. Throughout these six years of their education most of these students have been exposed and participated in many T/E design opportunities. Data collection results from *t*-test comparing gender provided interesting results. Given the engineering design experiences all students at all grade levels receive at this school, little if any gender differences were expected in the PATT-ELEM results. However, quite unexpectedly there were 16 items across four of the factor areas that showed significant differences.

Two implications emerge from these results: (1) the delivery of technology education in this school, and (2) how these elementary girls perceive their ability to do technological activity. First, because of the training of the faculty and longevity of the Children's Engineering program at this elementary school, students should have knowledge about what technology education is. What students do know is the design process and how to apply that knowledge in hands-on learning practices. Students are engaged in positive learning experiences and use critical thinking skills in the process but, according to the data, fall short in understanding the broader spectrum of technology. This implies that teachers engage students in the design process through various activities but may not have pedagogical content knowledge (PCK) in the delivery of technology education/Children's Engineering so that students have a broader understanding of technology. As well, the Children's Engineering program at this school is not a structured curriculum. Teachers use these strategies at their discretion which could result in a variance in how much or how little these students participate in Children's Engineering.

Second, the lack of PCK as described previously could also be related to the perception that girls, in this study, have of technology. From the data collection in this study there is an implication that teachers are not addressing the gender issue of encouraging girls to be more involved in technology careers or at least have a more positive attitude toward technology. The current teaching model, as practiced in this setting, is not encouraging girls to embrace technology related activity. All students, including girls, participate in technological design activities but, once again, are not grasping the broader scope of technology education.

Children's Engineering strategies have value and do expose children to the design process. Children who are engaged in learning naturally develop a positive attitude toward it. They provide the basics to technology education but the question is how to expose that technological understanding.

Recommendations for Further Research

The findings of this study provide a good foundation for further research using the newly, developed PATT-ELEM. The need for empirical research within the field of technology education has been well documented (Zuga, 1997; Lewis, 1999; NRC, 2011). The need for understanding elementary students' attitudes has been noted and an attempt to create an assessment tool has been demonstrated by this research.

Instrument Reliability

The low alpha value on the attitude section of the PATT-ELEM is substantial. To raise the credibility level of this assessment tool the following two recommendation are suggested for future research. The first recommendation for increasing the alpha score would be to eliminate the items that did not load on the factor analysis. The other recommendation would be to analyze the attitudes items for redundancy and determine a minimum number of items necessary to assess that factor area.

Demographic Questions

A review of some demographic questions used on the PATT-ELEM is recommended for clarity of understanding. Rephrasing of questions that are ambiguous could clear up misconceptions of what is being asked of the student.

Readability

Although the PATT-ELEM instrument was regarded as valid the issue of readability should be considered. Reassessing all survey items and reassessing their reading level to assure that a wide range of fifth grade students can read the survey is recommended. The instrument has its merits but a modification of vocabulary to address the age group is necessary to ensure instrument fidelity. Norland (2013) suggest that reducing syllables in words, substituting complex words with simpler ones, and shortening sentence length are ways to reduce reading levels of text. As recommended by Benjamin (2011) investigation into computerized language systems that address varying degrees of reading levels would be worthy of future research to assure that more students can read and understand the PATT-ELEM.

Classroom Practices and Gender Issues

An investigation into why gender differences occurred in a school that is immersed in a Children's Engineering/Technology Education program is also recommended future research. Emphasis on T/E design teaching strategies (de Vries, 1999; Kobella, 1989; Cajas, 2000; McLoughlin and Young, 2005) helps teachers and curriculum developers to develop instructional activities that guide students' thinking toward these ideas by providing relevant phenomena and useful questions that can motivate, stimulate, and support students. In this particular study, it appears that the T/E design teaching strategies used with this sampling of students are not addressing instilling a healthy interest in technology by girls. Following an intervention designed to rectify this issue, the PATT-ELEM could provide insight on how effectively any elementary technology education teaching strategies are working and address the lack of interest issues. It is recommended that the delivery of technology education/Children's Engineering be reviewed and strategies re-evaluated and incorporated into the elementary curriculum. These strategies should focus on improving teaching practices and concentrate on motivating the female gender to be more receptive to the technological world.

One of the primary motivations behind this research was the emphasis on developing technologically literate students in the US, particularly looking at how technology education is being implemented and assessed in elementary classrooms. The National Research Council (2011) stated in the Committee on Highly Successful Schools or Programs for K-12 STEM Education report that effective STEM instruction, particularly elementary age students, capitalizes on students' early interest and experiences, identifies and builds on what they know, engages them in STEM practices, and provides them with experiences to sustain their interest. Many national publications have provided recommendations for showing the significance of elementary technology education efforts (NAS, 2006, NAE & NRC, 2006, NRC, 2011). With this rising focus on how important it is to begin technology education/STEM instruction early on it is clear that tools are needed to evaluate the effectiveness of this instruction.

With this current emphasis on elementary technology education the development of this attitude assessment tool, the PATT-ELEM, is a step in determining the effectiveness of elementary technology education programs and understanding how elementary students feel about technology. Attitude research is an acceptable measure in determining technological literacy for all ages. Therefore, this research is a step in training elementary students to become technologically literate.

A limitation of this study is the small sample size.

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APPENDICES

Appendix A.

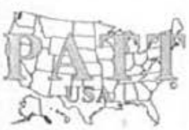
Pupils' Attitudes Toward Technology (PATT-USA) Instrument

Printed in U.S.A. NCS Trans-Optic® MP18-28215-321 A2403

PUPILS' ATTITUDE TOWARDS TECHNOLOGY

Developed by: Virginia Tech - Technology Education and Eindhoven University, The Netherlands

We are interested in your opinion on technology. Therefore, we would like you to answer some questions on this subject. This is not a test. There are no right or wrong answers. You are not to be graded on this. Do not take too much time for one question. You should only need about 25 minutes for the whole questionnaire. The first set of questions are about you so we can get to know you better. These are followed by statements about technology. Indicate to what extent you agree or disagree with them. In the last set of statements you only have to indicate agree, disagree or don't know.



Please give a short description of what you think technology is:

WRITE ONLY INSIDE THIS BLOCK

WRONG 1 (A) (TA) (N) (TD)
WRONG 2 (A) (TA) (N) (TD)
WRONG 3 (A) (TA) (N) (TD)
RIGHT 4 (A) ● (N) (TD)

1. Are you a boy or a girl? .... 1. (B) Boy (G) Girl
2. How old are you? .... 2. (12) or younger (13) (14) (15) (16) or older
3. What is your grade in school? 3. (6) (7) (8)

	Very Much	Much	Little	Nothing
4. If your father has a job, indicate to what extent it has to do with technology..... 4.	(VM)	(M)	(L)	(N)
5. If your mother has a job, indicate to what extent it has to do with technology.... 5.	(VM)	(M)	(L)	(N)

	Yes	No
6. Do you have technical toys, like Tinkertoy, Erector Set or LEGO at home? .... 6.	(Y) Yes	(N) No
7. Is there a technical workshop in your home? .... 7.	(Y) Yes	(N) No
8. Is there a personal computer in your home? .... 8.	(Y) Yes	(N) No
9. Do you think you will choose a technological profession? .... 9.	(Y) Yes	(N) No
10. Do you have brothers or sisters that have a technological profession or that are studying for it? .... 10.	(Y) Yes	(N) No
11. Are you taking or have you taken Technology Education/Industrial Arts? .... 11.	(Y) Yes	(N) No

	AGREE	TEND TO AGREE	NEUTRAL	TEND TO DISAGREE	DISAG
12. When something new is discovered, I want to know more about it immediately.......... 12.	(A)	(TA)	(N)	(TD)	(
13. Technology is as difficult for boys as it is for girls. .... 13.	(A)	(TA)	(N)	(TD)	(
14. Technology is good for the future of this country. .... 14.	(A)	(TA)	(N)	(TD)	(
15. To understand something of technology you have to take a difficult training course. .... 15.	(A)	(TA)	(N)	(TD)	(
16. At school you hear a lot about technology.......... 16.	(A)	(TA)	(N)	(TD)	(
17. I will probably choose a job in technology. .... 17.	(A)	(TA)	(N)	(TD)	(
18. I would like to know more about computers. .... 18.	(A)	(TA)	(N)	(TD)	(
19. A girl can very well have a technological job. .... 19.	(A)	(TA)	(N)	(TD)	(
20. Technology makes everything work better. .... 20.	(A)	(TA)	(N)	(TD)	(
21. You have to be smart to study technology.......... 21.	(A)	(TA)	(N)	(TD)	(
22. I would not like to learn more about technology at school. .... 22.	(A)	(TA)	(N)	(TD)	(
23. I like to read technological magazines.......... 23.	(A)	(TA)	(N)	(TD)	(
24. A girl can become a car mechanic.......... 24.	(A)	(TA)	(N)	(TD)	(
25. Technology is very important in life. .... 25.	(A)	(TA)	(N)	(TD)	(
26. Technology is only for smart people.......... 26.	(A)	(TA)	(N)	(TD)	(
27. Technology lessons are important. .... 27.	(A)	(TA)	(N)	(TD)	(
28. I will not consider a job in technology. .... 28.	(A)	(TA)	(N)	(TD)	(
29. There should be less TV and radio programs about technology.......... 29.	(A)	(TA)	(N)	(TD)	(
30. Boys are able to do practical things better than girls.......... 30.	(A)	(TA)	(N)	(TD)	(
31. Everyone needs technology.......... 31.	(A)	(TA)	(N)	(TD)	(
32. I would rather not have technology lessons at school.......... 32.	(A)	(TA)	(N)	(TD)	(
33. I do not understand why anyone would want a job in technology.......... 33.	(A)	(TA)	(N)	(TD)	(
34. If there was a school club about technology I would certainly join it. .... 34.	(A)	(TA)	(N)	(TD)	(
35. Girls are able to operate a computer.......... 35.	(A)	(TA)	(N)	(TD)	(
36. Technology has brought more good things than bad. .... 36.	(A)	(TA)	(N)	(TD)	(
37. You have to be strong for most technological jobs.......... 37.	(A)	(TA)	(N)	(TD)	(
38. Technology at home is something schools should teach about.......... 38.	(A)	(TA)	(N)	(TD)	(
39. I would enjoy a job in technology.......... 39.	(A)	(TA)	(N)	(TD)	(
40. I think visiting a factory is boring.......... 40.	(A)	(TA)	(N)	(TD)	(
41. Boys know more about technology than girls do. .... 41.	(A)	(TA)	(N)	(TD)	(
42. The world would be a better place without technology.......... 42.	(A)	(TA)	(N)	(TD)	(

Over Please

43.	To study technology you have to be talented.	43.	A	TA	N	TD	D
44.	I should be able to take technology as a school subject.	44.	A	TA	N	TD	D
45.	I would like a career in technology later on.	45.	A	TA	N	TD	D
46.	I am not interested in technology.	46.	A	TA	N	TD	D
47.	Boys are more capable of doing technological jobs than girls.	47.	A	TA	N	TD	D
48.	Using technology makes a country less prosperous.	48.	A	TA	N	TD	D
49.	You can study technology only when you are good at both mathematics and science.	49.	A	TA	N	TD	D
50.	There should be more education about technology.	50.	A	TA	N	TD	D
51.	Working in technology would be boring.	51.	A	TA	N	TD	D
52.	I enjoy repairing things at home.	52.	A	TA	N	TD	D
53.	More girls should work in technology.	53.	A	TA	N	TD	D
54.	Technology causes large unemployment.	54.	A	TA	N	TD	D
55.	Technology does not need a lot of mathematics.	55.	A	TA	N	TD	D
56.	Technology as a subject should be taken by all pupils.	56.	A	TA	N	TD	D
57.	Most jobs in technology are boring.	57.	A	TA	N	TD	D
58.	I think machines are boring	58.	A	TA	N	TD	D
59.	Girls prefer not to go to a technical school.	59.	A	TA	N	TD	D
60.	Because technology causes pollution, we should use less of it.	60.	A	TA	N	TD	D
61.	Everybody can study technology.	61.	A	TA	N	TD	D
62.	Technology lessons help to train you for a good job.	62.	A	TA	N	TD	D
63.	Working in technology would be interesting.	63.	A	TA	N	TD	D
64.	A technological hobby is boring.	64.	A	TA	N	TD	D
65.	Girls think technology is boring.	65.	A	TA	N	TD	D
66.	Technology is the subject of the future.	66.	A	TA	N	TD	D
67.	Everybody can have a technological job.	67.	A	TA	N	TD	D
68.	Not everyone needs technology lessons at school.	68.	A	TA	N	TD	D
69.	With a technological job your future is promised.	69.	A	TA	N	TD	D

FROM NOW ON YOU ONLY HAVE THREE CHOICES:

			AGREE	DISAGREE	DON'T KNOW
70.	When I think of technology I mostly think of computers.	70.	A	D	DK
71.	I think science and technology are related.	71.	A	D	DK
72.	In technology, you can seldom use your imagination.	72.	A	D	DK
73.	I think technology has little to do with our energy problem.	73.	A	D	DK
74.	When I think of technology, I mostly think of equipment.	74.	A	D	DK
75.	To me technology and science are the same.	75.	A	D	DK
76.	In my opinion, technology is not very old.	76.	A	D	DK
77.	In technology, you can think up new things.	77.	A	D	DK
78.	Working with information is an important part of technology.	78.	A	D	DK
79.	Technology is as old as humans.	79.	A	D	DK
80.	Elements of science are seldom used in technology.	80.	A	D	DK
81.	You need not be technological to invent a new piece of equipment.	81.	A	D	DK
82.	Technology has a large influence on people.	82.	A	D	DK
83.	I think technology is often used in science.	83.	A	D	DK
84.	Working with your hands is part of technology.	84.	A	D	DK
85.	In everyday life, I have a lot to do with technology.	85.	A	D	DK
86.	In technology, there is little opportunity to think up things yourself.	86.	A	D	DK
87.	Science and technology have nothing in common.	87.	A	D	DK
88.	The government can have influence on technology.	88.	A	D	DK
89.	I think the conversion of energy is also part of technology.	89.	A	D	DK
90.	In technology, you use tools.	90.	A	D	DK
91.	Technology is meant to make our life more comfortable.	91.	A	D	DK
92.	When I think of technology, I mainly think of computer programs.	92.	A	D	DK
93.	Only technicians are in charge of technology.	93.	A	D	DK
94.	Technology has always to do with mass production.	94.	A	D	DK
95.	In technology, there are less opportunities to do things with your hands.	95.	A	D	DK
96.	Working with materials is an important part of technology.	96.	A	D	DK
97.	Technology has little to do with daily life.	97.	A	D	DK
98.	When I think of technology I mainly think of working with wood.	98.	A	D	DK
99.	Technology can mainly be found in industry.	99.	A	D	DK
100.	There is a relationship between technology and science.	100.	A	D	DK

Appendix B.

List of PATT Studies Performed After 1993

Year Published	Researchers	Where	Number of Participants	Age/Grades	How PATT was used	Focus of Study/Conclusion
1994	Shafiee	Texas	322	College level	Used with SSATT (Secondary Student Attitudes Toward Technology	Identify factors underlying attitudes of college students
1996	Meide	Botswana	800	Form 5 students – final year of secondary school. Ages: 16-20	Developed a PATT instrument for assessing Botswana students	Influence direction of Design and Technology education
1998	Boser Palmer Daugherty	Illinois	155 students – Pretest 127 students - Posttest	Grade: 7th grade Ages: 12-14	PATT-USA: Pretest and Posttest	Influence of technology education program
1998	Jarvis Rennie	England/Australia	315 English children 745 Australia children	Ages: 7–12	Writing/Drawing Activity used the essay topic from the PATT project	Similar results from both countries
1999	VanRensburg Ankiewicz	South Africa	500 girls and 510 boys Three groups of learners	Grades: 9 and 10 Ages 12 and 16	Developed the ATP (Attitudinal Technology Profile)	Data were not as valid and reliable in South Africa as in the other 20 countries
1999	Volk Yip	Hong Kong	3,481	Junior High	Developed PATT-HK	Significant differences existed between girls and boys
2001 (Follow up from 1999)	VanRensburg Ankiewicz	South Africa	439	Grades 9 and 10	Used Attitudinal Technology Profile (ATP)	Evaluated the effects of curricula
2002	Becker Mau*n*saiyat	Thailand	292 boys and 324 girls	Secondary schools Grades: 7,8, and 9 Ages: 11 to 16 year	Developed Technology Attitude and Concept Scale (TACS-Thai)	Adapted from Technology Attitude Scale (TAS-USA) and the Pupils' Attitudes Towards Technology (PATT-USA)
2002	VanDehey Thorsen (Futurekids, Inc.)	Illinois, Washington, and North Carolina	Approximately 250 in each session	Fifth grade	Evaluate the effect of a Model Technology Integration Program	Little change on the PATT instrument, not the case for the CAQ (Computer Attitude Questionnaire).
2003	Volk Yip Lo	Hong Kong	2,800	22 secondary schools	Duplicated from 1999 study PATT2 Developed PATT2-HK	Design and Technology program shows positive impact among girls
2005	Yu, Han,Hsu, & Lin	Taiwan	Unknown	Unknown	Developed Attitude Toward Technology Scale for Junior High School Students	Instrument development for target populations
2007	Khunyakari Mehrotra Chunawala Natarajan	India	644	Class 8 Ages: 13-14	Survey questionnaires inspired by the PATT instrument	Informed decisions about several aspects of technology education curriculum and classroom practice.
2006	Bain Rice	Alabama	59	Sixth grade	Used PATT and CAQ (Computer Attitude Questionnaire)	Notable gender differences
2008	Yurdugul Askar	Turkey -	3028	Ages: 10-16	PATT - TR	Only the affective components of PATT questionnaire were used
2008	Mawson	New Zealand	7	Ages: 5–10	Used instrument adapted from the PATT for young children	Used the 1998 Rennie/Jarvis instrument
2012 (Follow-up from 2005 study)	Yu, Lin,Hau, & Hsu	Taiwan	1330	Grade: 7	Used PATT and TAM to construct a model and to test and verify this model's appropriateness.	Study supported a model of junior high school students' attitudes toward technology based on TAM (technology acceptance model)
2012		United Kingdom	Online – results are being processed.			Survey closed Easter, 2013

Appendix C.

Instructional Review Board Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: October 9, 2014

TO: John Wells, Charlotte Ann Holter

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)

PROTOCOL TITLE: Assessing Elementary Pupils’ Attitudes toward Technology

IRB NUMBER: **14-647**

Effective October 8, 2014, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date:	**October 8, 2014**
Protocol Expiration Date:	**October 7, 2015**
Continuing Review Due Date*:	**September 23, 2015**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

Appendix D.

Parent and Student Recruitment Letter and Permission Form

Dear Parents,

You are being contacted because you have a student in fifth grade at John Wayland Elementary School. My name is Charlotte Holter and I am a graduate student in the Integrative STEM Education program at Virginia Tech. I am also the Challenge (Gifted) teacher at the school. I am working on a research study regarding elementary students' attitudes toward technology. I am beginning this research study under the advisement of Dr. John G. Wells who is the program leader of the Integrative STEM Education program at Virginia Tech.

We are seeking fifth grade students to be part of this new study. The purpose of this study is to use the PATT (Pupils' Attitudes toward Technology) Instrument with fifth graders to see what their attitudes are as well as testing the instrument to see if it a viable tool to use for future studies. My interaction with your child will consist of two sessions in the computer lab where they will anonymously answer survey questions concerning technology. A sample question from the survey is "I would enjoy a job in technology." No identifying information on any child will be collected and participation is voluntary. Your child is free to discontinue at any time.

Please discuss the study with your child and if they would like to participate, please have them sign the Assent form which is included on your permission form. This study is simply collecting data about what fifth grade students think and has nothing with do with gifted or academic placement or will affect their grades.

If you will allow your child to participate in this study please sign the attached form and return to your child's teacher by _________. The data collection will take place from _______ to _______. I hope you will give me the opportunity to gather data from this group of fifth graders. If you have questions, please contact me at cholter@rockingham.k12.va.us or call me at 540-820-9098.

If you see additional information about the study please contact Dr. Moore/ Instructional Review Board for Virginia Tech at moored@vt.edu or 540-231-4991.

Thank you in advance for your consideration,

Charlotte P. Holter
Graduate Student

Permission Form for Holter/Virginia Tech Study

Please return form to classroom teacher by _____________

Dear parents:

My child, ________________________________ (first and last name) has permission to take the PATT survey to be administered during two computer lab sessions and understand that they will remain anonymous in the data collection. Any identifying information will be kept confidential.

__________________________________ __________________________________

Printed parent(s) name

__________________________________ __________________________________

Parent(s) signature(s)

Date: _______________

Student Assent:

I, ____________________________________ (student first and last name), agree to participate in the study that Mrs. Holter is doing with me. I understand that participating will not affect my grades and that I can discontinue at any time during the two sessions.

____

Student signature

Date: ________________________________

Please return this form to Mrs. Holter at John Wayland Elementary School.

Appendix E.

Permission To Use And Modify PATT-USA Instrument

From: "Vries, M.J. de" <M.J.d.Vries@tue.nl> February 3, 2015 10:37:37 AM
Subject: RE: Permission
To: **Charlotte Holter**

Permission granted, Charlotte. All the best with your research!

Marc

-----Original Message-----
From: Charlotte Holter [mailto:cholter@rockingham.k12.va.us]
Sent: dinsdag 3 februari 2015 15:50
To: Vries, M.J. de
Subject: Permission

Dr. de Vries,
Hope you are well! I believe that you granted permission for me to use/modify the PATT instrument with elementary students, perhaps it was a verbal agreement. As I am writing my dissertation I realized that I do not have documentation that honors that request. Could you kindly give me that permission as a reply to this email? See you in Milwaukee.
Thank you,
Charlotte

Charlotte P. Holter
President, Virginia Children's Engineering Council[Image:22414_95345_0.jpg] Challenge Teacher (Gifted Education) John Wayland Elementary/Linville-Edom Elementary
801 N. Main Street
Bridgewater, VA 22812

Do not resent growing old. Many are denied the privilege. (Anonymous)

Appendix F.

Cover Letter And Correction of Terminology Procedures For Interraters

Date: ________________________

Dear ________________________,

Thank you for agreeing to be an inter-rater for this study.

The purpose of the PATT (Pupils' Attitudes toward Technology) instrument was to assess middle school students' attitudes toward technology. It was an attempt to develop an understanding of their dispositions toward technology. There are correlations between having a broad concept of technology and positive attitudes toward technology.

In 1988 the PATT instrument was developed and implemented in the USA with 10,000 middle and high school students. Twenty-five years have passed and technological wording that was appropriate for that time has become obsolete or antiquated.

I am soliciting your help to establish correction of terminology, content validity, and construct validity. The directions for completing the criteria checklist are as follows:

Correction of Terminology

1. Review the highlighted/bold/boxed items in the protocol and perform an analysis to correct problematic terminology.
2. Rate the item as appropriate or inappropriate.
3. If the word is deemed inappropriate provide a modification that would be appropriate for understanding today.

Content and Construct Validity

1. Using the provided tool analyze each item for how well it relates to the content domain by placing a check in the appropriate or inappropriate column.
2. Follow the same procedure for measuring the construct domain.

Please complete this within two weeks and return the electronic version to charlo56@vt.edu by ________________.

The intent of this procedure is to insure content validity and construct validity and better understanding for those taking the survey today. Thank you for your assistance in this study.

Respectfully,

Charlotte P. Holter

Instructions: Look over the original PATT-USA instrument. Following this instrument are instructions to guide through the correction of terminology process.

PUPILS' ATTITUDE TOWARDS TECHNOLOGY

We are interested in your opinion on technology. Therefore, we would like you to answer some questions on this subject. This is not a test. There are no right or wrong answers. You are not to be graded on this. Do not take too much time for one question. You should only need about 25 minutes for the whole questionnaire. The first set of questions are about you so we can get to know you better. These are followed by statements about technology. Indicate to what extent you agree or disagree with them. In the first set of statements you only have to indicate agree, disagree or don't know.

Please give a short description of what you think technology is:

#					
1	Are you a girl or boy?	**Boy**	**Girl**		
2	How old are you?	**9**	**10**	**11**	**12**
3	What is your grade in school	**5th**			
		Very much	**Much**	**Little**	**Nothing**
4	If your father has a job indicate to what extent it has to do with technology				
5	If your mother has a job indicate to what extent it has to do with technology				

		Yes	No
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?		
7	Is there a technical workshop in your home?		
8	Is there a personal computer in your home?		
9	Do you think you will choose a technological profession?		
10	Do you have brothers or sisters that have a technological profession or that are studying for it?		
11	Are you taking or have you taken Technology Education/Industrial Arts?		

PATT Instrument, continued

		AGREE	TEND TO AGREE	NEUTRAL	TEND TO DISAGREE	DISAGREE
12	When something new is discovered, I want to know more about it immediately.					
13	Technology is as difficult for boys as it is for girls.					
14	Technology is good for the future of this country.					
15	To understand something of technology you have to take a difficult training course.					
16	At school you hear a lot about technology.					
17	I will probably choose a job in technology.					
18	I would like to know more about computers.					
19	A girl can very well have a technological job.					
20	Technology makes everything work better.					
21	You have to be smart to study technology.					
22	I would not like to learn more about technology at school.					
23	I like to read technological magazines.					
24	A girl can become a car mechanic.					
25	Technology is very important in life.					
26	Technology is only for smart people.					
27	Technology lessons are important.					
28	I will not consider a job in technology.					
29	There should be less TV and radio programs about technology.					
30	Boys are able to do practical things better than girls.					
31	Everyone needs technology.					
32	I would rather not have technology lessons at school.					
33	I do not understand why anyone would want a job in technology.					
34	If there were a school club about technology I would certainly join it.					
35	Girls are able to operate a computer					
36	Technology has brought more good things than bad.					
37	You have to be strong for most technological jobs.					
38	Technology at home is something schools should teach about.					
39	I would enjoy a job in technology					

PATT Instrument, continued

		AGREE	TEND TO AGREE	NEUTRAL	TEND TO DISAGREE	DISAGREE
40	I think working in a factory is boring.					
41	Boys know more about technology than girls do.					
42	The world would be a better place without technology.					
43	To study technology you have to be talented.					
44	I should be able to take technology as a school subject.					
45	I would like a career in technology later on.					
46	I am not interested in technology.					
47	Boys are more capable of doing technological jobs than girls.					
48	Using technology makes a country less prosperous.					
49	You can study technology only when you are good at both mathematics and science					
50	There should be more education about technology.					
51	Working in technology would be boring.					
52	I enjoy repairing things at home.					
53	More girls should work in technology.					
54	Technology causes large unemployment.					
55	Technology does not need a lot of mathematics.					
56	Technology as a subject should be taken by all pupils.					
57	Most jobs in technology are boring.					
58	I think machines are boring.					
59	Girls prefer not to go to a technical school.					
60	Because technology causes pollution, we should use less of it.					
61	Everybody can study technology.					
62	Technology lessons help to train you for a good job.					
63	Working in technology would be interesting.					
64	A technological hobby is boring.					
65	Girls think technology is boring.					
66	Technology is the subject of the future.					
67	Everyone can have a technological job.					
68	Not everyone needs technological lessons at school.					
69	With a technological job your future is promised.					

PATT Instrument, continued

	FROM NOW ON YOU ONLY HAVE THREE CHOICES:	**Agree**	**Disagree**	**Don't know**
70	When I think of technology I mostly think of computers.			
71	I think science and technology are related.			
72	In technology, you can seldom use your imagination.			
73	I think technology has little to do with our energy problem.			
74	When I think of technology, I mostly think of equipment			
75	To me technology and science are the same.			
76	In my opinion, technology is not very old.			
77	In technology, you can think up new things.			
78	Working with information is an important part of technology.			
79	Technology is as old as humans.			
80	Elements of science are seldom used in technology.			
81	You need not be technological to invent a new piece of equipment.			
82	Technology has a lot of influence on people.			
83	I think technology is often used in science.			
84	Working with your hands is part of technology.			
85	In everyday life, I have a lot to do with technology.			
86	In technology, there is little opportunity to think up things yourself.			
87	Science and technology have nothing in common.			
88	The government can have influence on technology.			
89	I think the conversion of energy is also part of technology.			
90	In technology, you use tools.			
91	Technology is meant to make our life more comfortable.			
92	When I think of technology, I mainly think of computer programs.			
93	Only technicians are in charge of technology.			
94	Technology has always to do with mass production.			
95	In technology, there are opportunities to do things with your hands.			
96	Working with materials is an important part of technology			
97	Technology has little to do with daily life.			
98	When I think of technology I mainly think of working with wood.			
99	Technology can mainly be found in industry.			
100	There is a relationship between technology and science.			

Correction of Terminology Procedure

Inter-rater instructions:
You have seen the survey in its original state. From this survey the following items have words and concepts that may be considered irrelevant, antiquated, or not contemporary. Please evaluate the shaded words/concepts that are listed below by checking whether they are appropriate or inappropriate when using with elementary students today. Modify as appropriate.

Question #	Question (Words)	Current (No modification)	Outdated (Modification needed)	Modification of inappropriate word
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?			
11	Are you taking or have you taken Technology Education/Industrial Arts?			
23	I like to read technological magazines.			
29	There should be less TV and radio programs about technology.			
40	I think working in a factory is boring.			
59	Girls prefer not to go to a technical school.			

Question #	Question (Concept)	Appropriate	Inappropriate	Modification of inappropriate concept
7	Is there a technical workshop in your home?			

Appendix G.

Correction of Terminology Rubric for Interraters

Dear interraters,

Below are the results of your PATT instrument evaluation. Using what you have said I have consolidated your suggestions into a new document, which you will find below your responses. Please look over how the new version looks and indicate an acceptance/rejection response on each item. Once we get the instrument corrected I will send a new rubric for analyzing this instrument for content and construct validity.
Thank you,
Charlotte Holter

Correction of Terminology Procedure
Inter-rater instructions:
You have seen the survey in its original state. From this survey the following items have words and concepts that may be considered irrelevant, antiquated, or not contemporary. Please evaluate the shaded words/concepts that are listed below by checking whether they are appropriate or inappropriate when using with elementary students today. Modify as appropriate.

Question #	Question (Words)	Current (No modification)	Outdated (Modification needed)	Modification of inappropriate word
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?		X X X	Smart phone, gaming system, radio controlled vehicles K'NEX, LEGO, MagnaBlox Remove Tinkertoy – Add K'NEX
11	Are you taking or have you taken Technology Education/Industrial Arts?		X X X	Classes where you learn about the processes and knowledge related to technology Any Technology Education classes? Remove Industrial Arts – consider Career and Technical Education courses
23	I like to read technological magazines.		X X X	Print or online magazines about technology Technical magazines Restate as technology magazines

29	There should be less TV and radio programs about technology.	X	X X	Internet information and videos Omit radio programs
40	I think working in a factory is boring.	X X	X	Manufacturing plant
59	Girls prefer not to go to a technical school.	X	X X	Career and technical Change to "not to study technology"

Question #	Question (Concept)	Appropriate	Inappropriate	Modification of inappropriate concept
7	Is there a technical workshop in your home?	X	X X	Are there any technical tools available….? Omit question

Red: Rater 1 **Blue: Rater 2** **Green: Rater 3**

INTER-RATERS: Please indicate your acceptance or rejection of the modified statements.

UPDATED CORRECTIONS

Question #	Question (Words)	Accept	Reject
6	Do you have technical toys, like LEGOs, K'NEX, MagnaBlox, or Smartphones at home?		
11	Are you taking or have you taken Technology Education classes where you learn processes and systems?		
23	I like to read technology or technical magazines.		
29	There should be less TV or Internet information about technology.		
40	I think working in a factory or manufacturing plant is boring.		
59	Girls prefer not to study technology or go to a career and technical school.		

Question #	Question (Concept)	Accept	Reject
7	Are there technical tools available in your home?		

If you reject an item please provide feedback or rationale:

Appendix H.

Content and Construct Interrater Validation Form

Content and Construct Validation Instructions

Read the operational definition of the PATT-ELEM instrument
Definition:
The PATT instrument is focused on understanding technological literacy and attitudes toward technology. The goal of the PATT instrument is to determine students' attitude toward technology and their understanding of technology related concepts.

Content Validity

To assess the PATT-ELEM Instrument for content validity please evaluate the wording of item and provide your rating on how well it measure the operational definition.

Construct Validity

To assess the PATT-ELEM Instrument for construct validity please evaluate and provide your rating on how well each item measures the overall construct: technological literacy.

Please check the appropriate box for how well each item reflects each category: content and construct

		Content			Construct	
		Appropriate	Inappropriate		Appropriate	Inappropriate
1	Are you a boy or a girl?					
2	How old are you?					
3	What is your grade in school					
4	If your father has a job indicate to what extent it has to do with technology					
5	If your mother has a job indicate to what extent it has to do with technology					
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?					
7	Is there a technical workshop in your home?					
8	Is there a personal computer in your home?					
9	Do you think you will choose a technological profession?					

Content and Construct Inter-rater Validation, continued

		Appropriate	Inappropriate		Appropriate	Inappropriate
10	Do you have brothers or sisters that have a technological profession or that are studying for it?					
11	Are you taking or have you taken Technology Education/Industrial Arts?					
12	When something new is discovered, I want to know more about it immediately.					
13	Technology is as difficult for boys as it is for girls.					
14	Technology is good for the future of this country.					
15	To understand something of technology you have to take a difficult training course.					
16	At school you hear a lot about technology.					
17	I will probably choose a job in technology.					
18	I would like to know more about computers.					
19	A girl can very well have a technological job.					
20	Technology makes everything work better.					
21	You have to be smart to study technology.					
22	I would not like to learn more about technology at school.					
23	I like to read technological magazines.					
24	A girl can become a car mechanic.					
25	Technology is very important in life.					
26	Technology is only for smart people.					
27	Technology lessons are important.					
28	I will not consider a job in technology.					
29	There should be less TV and radio programs about technology.					
30	Boys are able to do practical things better than girls.					
31	Everyone needs technology.					
32	I would rather not have technology lessons at school.					
33	I do not understand why anyone would want a job in technology.					
34	If there were a school club about technology I would certainly join it.					

Content and Construct Inter-rater Validation, continued

		Appropriate	Inappropriate		Appropriate	Inappropriate
35	Girls are able to operate a computer					
36	Technology has brought more good things than bad.					
37	You have to be strong for most technological jobs.					
38	Technology at home is something schools should teach about.					
39	I would enjoy a job in technology					
40	I think working in a factory is boring.					
41	Boys know more about technology than girls do.					
42	The world would be a better place without technology.					
43	To study technology you have to be talented.					
44	I should be able to take technology as a school subject.					
45	I would like a career in technology later on.					
46	I am not interested in technology.					
47	Boys are more capable of doing technological jobs than girls.					
48	Using technology makes a country less prosperous.					
49	You can study technology only when you are good at both mathematics and science					
50	There should be more education about technology.					
51	Working in technology would be boring.					
52	I enjoy repairing things at home.					
53	More girls should work in technology.					
54	Technology causes large unemployment.					
55	Technology does not need a lot of mathematics.					
56	Technology, as a subject, should be taken by all pupils.					
57	Most jobs in technology are boring.					
58	I think machines are boring.					
59	Girls prefer not to go to a technical school.					
60	Because technology causes pollution, we should use less of it.					
61	Everybody can study technology.					
62	Technology lessons help to train you for a good job.					

63	Working in technology would be interesting.					

Content and Construct Inter-rater Validation, continued

		Appropriate	Inappropriate		Appropriate	Inappropriate
64	A technological hobby is boring.					
65	Girls think technology is boring.					
66	Technology is the subject of the future.					
67	Everyone can have a technological job.					
68	Not everyone needs technological lessons at school.					
69	With a technological job your future is promised.					
70	When I think of technology I mostly think of computers.					
71	I think science and technology are related.					
72	In technology, you can seldom use your imagination.					
73	I think technology has little to do with our energy problem.					
74	When I think of technology, I mostly think of equipment					
75	To me technology and science are the same.					
76	In my opinion, technology is not very old.					
77	In technology, you can think up new things.					
78	Working with information is an important part of technology.					
79	Technology is as old as humans.					
80	Elements of science are seldom used in technology.					
81	You need not be technological to invent a new piece of equipment.					
82	Technology has a lot of influence on people.					
83	I think technology is often used in science.					
84	Working with your hands is part of technology.					
85	In everyday life, I have a lot to do with technology.					
86	In technology, there is little opportunity to think up things yourself.					
87	Science and technology have nothing in common.					
88	The government can have influence on technology.					

89	I think the conversion of energy is also part of technology.					
90	In technology, you use tools.					
91	Technology is meant to make our life more comfortable.					

Content and Construct Inter-rater Validation, continued

		Appropriate	Inappropriate		Appropriate	Inappropriate
92	When I think of technology, I mainly think of computer programs.					
93	Only technicians are in charge of technology.					
94	Technology has always to do with mass production.					
95	In technology, there are opportunities to do things with your hands.					
96	Working with materials is an important part of technology					
97	Technology has little to do with daily life.					
98	When I think of technology I mainly think of working with wood.					
99	Technology can mainly be found in industry.					
100	There is a relationship between technology and science.					

Appendix I.

PATT-ELEM

PATT-ELEM

Pupils' Attitudes Toward Technology – Elementary Version

Please give a short description of what you think technology is:

1	Are you a boy or a girl?	**Boy**	**Girl**		
2	How old are you?	**9**	**10**	**11**	**12**
3	What is your grade in school	**5th**			
		Very much	**Much**	**Little**	**Nothing**
4	If your father has a job indicate to what extent it has to do with technology				
5	If your mother has a job indicate to what extent it has to do with technology				
		Yes	**No**		
6	Do you have technical toys, like Tinkertoy, Erector Set, or LEGO at home?				
7	Is there a technical workshop in your home?				
8	Is there a personal computer in your home?				
9	Do you think you will choose a technological profession?				
10	Do you have brothers or sisters that have a technological profession or that are studying for it?				
11	Are you taking or have you taken Technology Education/Industrial Arts?				

		AGREE	**TEND TO AGREE**	**NEUTRAL**	**TEND TO DISAGREE**	**DISAGREE**
12	When something new is discovered, I want to know more about it immediately.					
13	Technology is as difficult for boys as it is for girls.					
14	Technology is good for the future of this country.					
15	To understand something of technology you have to take a difficult training course.					
		AGREE	**TEND TO AGREE**	**NEUTRAL**	**TEND TO DISAGREE**	**DISAGREE**
16	At school you hear a lot about technology.					

17	I will probably choose a job in technology.					
18	I would like to know more about computers.					
19	A girl can very well have a technological job.					
20	Technology makes everything work better.					
21	You have to be smart to study technology.					
22	I would not like to learn more about technology at school.					
23	I like to read technological magazines.					
24	A girl can become a car mechanic.					
25	Technology is very important in life.					
26	Technology is only for smart people.					
27	Technology lessons are important.					
28	I will not consider a job in technology.					
29	There should be less TV and radio programs about technology.					
30	Boys are able to do practical things better than girls.					
31	Everyone needs technology.					
32	I would rather not have technology lessons at school.					
33	I do not understand why anyone would want a job in technology.					
34	If there were a school club about technology I would certainly join it.					
35	Girls are able to operate a computer					
36	Technology has brought more good things than bad.					
37	You have to be strong for most technological jobs.					
38	Technology at home is something schools should teach about.					
39	I would enjoy a job in technology					
40	I think working in a factory is boring.					
41	Boys know more about technology than girls do.					
42	The world would be a better place without technology.					
43	To study technology you have to be talented.					
44	I should be able to take technology as a school subject.					
45	I would like a career in technology later on.					
46	I am not interested in technology.					
47	Boys are more capable of doing technological jobs than girls.					
48	Using technology makes a country less prosperous.					
49	You can study technology only when you are good at both mathematics and science					
50	There should be more education about technology.					
		AGREE	**TEND TO AGREE**	**NEUTRAL**	**TEND TO DISAGREE**	**DISAGREE**
51	Working in technology would be boring.					

52	I enjoy repairing things at home.					
53	More girls should work in technology.					
54	Technology causes large unemployment.					
55	Technology does not need a lot of mathematics.					
56	Technology as a subject should be taken by all pupils.					
57	Most jobs in technology are boring.					
58	I think machines are boring.					
59	Girls prefer not to go to a technical school.					
60	Because technology causes pollution, we should use less of it.					
62	Technology lessons help to train you for a good job.					
63	Working in technology would be interesting.					
64	A technological hobby is boring.					
65	Girls think technology is boring.					
66	Technology is the subject of the future.					
67	Everyone can have a technological job.					
68	Not everyone needs technological lessons at school.					
69	With a technological job your future is promised.					
	FROM NOW ON YOU ONLY HAVE THREE CHOICES:	**Agree**	**Disagree**	**Don't know**		
70	When I think of technology I mostly think of computers.					
71	I think science and technology are related.					
72	In technology, you can seldom use your imagination.					
73	I think technology has little to do with our energy problem.					
74	When I think of technology, I mostly think of equipment					
75	To me technology and science are the same.					
76	In my opinion, technology is not very old.					
77	In technology, you can think up new things.					
78	Working with information is an important part of technology.					
79	Technology is as old as humans.					
80	Elements of science are seldom used in technology.					
81	You need not be technological to invent a new piece of equipment.					
82	Technology has a lot of influence on people.					
83	I think technology is often used in science.					
84	Working with your hands is part of technology.					
85	In everyday life, I have a lot to do with technology.					
86	In technology, there is little opportunity to think up things yourself.					
87	Science and technology have nothing in common.					
88	The government can have influence on technology.					

89	I think the conversion of energy is also part of technology.			
90	In technology, you use tools.			
91	Technology is meant to make our life more comfortable.			
92	When I think of technology, I mainly think of computer programs.			
93	Only technicians are in charge of technology.			
94	Technology has always to do with mass production.			
95	In technology, there are opportunities to do things with your hands.			
96	Working with materials is an important part of technology			
97	Technology has little to do with daily life.			
98	When I think of technology I mainly think of working with wood.			
99	Technology can mainly be found in industry.			
100	There is a relationship between technology and science.			

Appendix J.

Script For Administering The PATT-ELEM Instrument To Students

Instructions for Administering PATT-ELEM Survey

FIRST SESSION:
-As students arrive in the computer lab hand out a card that has student name and the identification code they will be using to log in to take the survey.
Administrator gives the following instructions to students taking the first part of the survey
SAY:
"My name is Mrs. Holter and I'm a teacher here at John Wayland Elementary School. Today you will be taking a survey that tells me what you think about technology. This survey will be given to all participating fifth graders here at this school and focuses on the attitude you have toward technology. The information we get from the survey will help us understand how to teach technology to elementary students.
Participation in this survey is voluntary. The answers you choose will not be shared with anyone. There are no penalties for doing this survey. It simply tells us what you think.
This survey should take you about 30 minutes or less to complete. There are fifty questions to answer. The answers will have two to five answer choices to select from. You are to answer the question to the best of your ability. You will have to select an answer to move to the next question. If you are having trouble with reading a word please raise your hand and I will help you with it.
Please go now to the **_____** *button on your computer screen. Click one time on it and please wait for further instructions."*
(Make sure all students are at the same place)
SAY:
"You will see the words, '**PATT for Kids'** *on your screen. If you do not see that raise your hand. PATT stands for Pupils' Attitudes Towards Technology. Underneath that you will see a place to put in your assigned survey code. Type in the code that appears on your card and raise your hand. I will make sure you have entered it correctly. Once I say it is OK you may click on the star to begin. We will be doing a sample question together before starting the survey."*
(Assist students in finding their codes and check codes before students log in)
SAY:
Everyone take a look at the sample question. Read it to yourself as I read it aloud.
"Choose an answer that best answers this statement. 'I like pizza.' Your answer choices are Agree, Tend to Agree, Neutral, Tend to Disagree, Disagree. Choose the one that best states how you feel about whether or not you like pizza. "
(Wait for students to answer)
"If you are happy with that answer you may click the 'next' *button. You may change an answer before you click the* 'next' *button but you cannot go back to a question once you click that button."*
"Any questions about how to answer questions?"
(Answer any questions students may ask)
SAY:

"You should carefully answer each question before you move on to the next question.

Go ahead and complete the entire survey now by yourself. If you need help, raise your hand.

*After you have answered the last question, click on the "*next*" button to exit the survey and let me know that you are done.*

Are there any questions?

(Answer any questions students may ask)

You may begin"

SECOND SESSION
-As students arrive in the computer lab hand out the card that has student name and the identification code they will be using to log in to take the survey
Administrator gives the following instructions to students taking the second part of the survey
SAY:
*"Last time you were here we did the first part of the '***PATT for Kids'** *survey where you answered questions about your attitude towards technology. Today we will be finishing that survey.*
Please click on the **____** *button that is on your computer screen now.*
*Look for '***PATT for Kids'** *on your screen. If you do not see that raise your hand. Underneath that you will see a place to put in your assigned identifying code. Type in the code that appears on your card and raise your hand. I will make sure you have entered it correctly. Once I say it is OK you may click on the star to begin.*
(Assist students in finding their codes and check codes before students log in)
SAY:
*"This time we will not be doing a sample question this time since you already know how to answer questions. You will start with the question that appears on your screen. Remember that you can change an answer before you click the '*next*' button but once you click '*next*' you will not be able to go back.*

Go ahead and complete the entire survey now by yourself. If you need help, raise your hand.

*After you have answered the last question, click on the "*next*" button to exit the survey and let me know that you are done.*

Are there any questions?
(Answer any questions students may ask)
You may begin.

Appendix K.

Interrater Responses for Content Validation

Interrater Responses for Construct Validation

X indicated acceptance that content was reflective of operational definition
O indicated rejection that content was reflective of operational definition

Item	Expert 1	Expert 2	Expert 3	Number in agreement	Item CVI
1	X	X	X	3	1.0
2	X	X	X	3	1.0
3	X	X	X	3	1.0
4	X	X	X	3	1.0
5	X	X	X	3	1.0
6	X	X	X	3	1.0
7	X	X	X	3	1.0
8	X	X	X	3	1.0
9	X	X	X	3	1.0
10	X	X	X	3	1.0
11	X	X	X	3	1.0
12	X	X	X	3	1.0
13	X	X	X	3	1.0
14	X	X	X	3	1.0
15	X	X	X	3	1.0
16	X	X	X	3	1.0
17	X	X	X	3	1.0
18	X	X	X	3	1.0
19	X	X	X	3	1.0
20	X	X	X	3	1.0
21	X	X	X	3	1.0
22	X	X	X	3	1.0
23	X	X	X	3	1.0
24	X	X	X	3	1.0
25	X	X	X	3	1.0
26	X	X	X	3	1.0
27	X	X	X	3	1.0
28	X	X	X	3	1.0
29	X	X	X	3	1.0
30	X	X	X	3	1.0

31	X	X	X	3	1.0
32	X	X	X	3	1.0
33	X	X	X	3	1.0
34	X	X	X	3	1.0
35	X	X	X	3	1.0
36	X	X	X	3	1.0
37	X	X	X	3	1.0
Item	Expert 1	Expert 2	Expert 3	Number in agreement	Item CVI
38	X	X	X	3	1.0
39	X	X	X	3	1.0
40	X	X	X	3	1.0
41	X	X	X	3	1.0
42	X	X	X	3	1.0
43	X	X	X	3	1.0
44	X	X	X	3	1.0
45	X	X	X	3	1.0
46	X	X	X	3	1.0
47	X	X	X	3	1.0
48	X	X	X	3	1.0
49	X	X	X	3	1.0
50	X	X	X	3	1.0
51	X	X	X	3	1.0
52	X	X	X	3	1.0
53	X	X	X	3	1.0
54	X	X	X	3	1.0
55	X	X	X	3	1.0
56	X	X	X	3	1.0
57	X	X	X	3	1.0
58	X	X	X	3	1.0
59	X	X	X	3	1.0
60	X	X	X	3	1.0
61	X	X	X	3	1.0
62	X	X	X	3	1.0
63	X	X	X	3	1.0
64	X	X	X	3	1.0
65	X	X	X	3	1.0
66	X	X	X	3	1.0
67	X	X	X	3	1.0
68	X	X	X	3	1.0
69	X	X	X	3	1.0
70	X	X	X	3	1.0
71	X	X	X	3	1.0
72	X	X	X	3	1.0
73	X	X	X	3	1.0

74	X	X	X	3	1.0
75	X	X	X	3	1.0
76	X	X	X	3	1.0
77	X	X	X	3	1.0
78	X	X	X	3	1.0
79	X	X	X	3	1.0
80	X	X	X	3	1.0
Item	Expert 1	Expert 2	Expert 3	Number in agreement	Item CVI
81	X	X	X	3	1.0
82	X	X	X	3	1.0
83	X	X	X	3	1.0
84	X	X	X	3	1.0
85	X	X	X	3	1.0
86	X	X	X	3	1.0
87	X	X	X	3	1.0
88	X	X	X	3	1.0
89	X	X	X	3	1.0
90	X	X	X	3	1.0
91	X	X	X	3	1.0
92	X	X	X	3	1.0
93	X	X	X	3	1.0
94	X	X	X	3	1.0
95	X	X	X	3	1.0
96	X	X	X	3	1.0
97	X	X	X	3	1.0
98	X	X	X	3	1.0
99	X	X	X	3	1.0
100	X	X	X	3	1.0

Appendix L.

Interrater Responses for Construct Validation

Interrater Responses for Construct Validation

X indicates acceptance that items met the constructs of the operational definition
0 indicates rejection that items do not meet the constructs of the operational definition

Item	Expert 1	Expert 2	Expert 3	Number in agreement	Item CVI
1	X	X	X	3	1.0
2	X	X	X	3	1.0
3	X	X	X	3	1.0
4	X	X	X	3	1.0
5	X	X	X	3	1.0
6	X	X	X	3	1.0
7	X	X	X	3	1.0
8	X	X	X	3	1.0
9	X	X	X	3	1.0
10	X	X	X	3	1.0
11	X	X	X	3	1.0
12	X	X	X	3	1.0
13	X	X	X	3	1.0
14	X	X	X	3	1.0
15	X	X	X	3	1.0
16	X	X	X	3	1.0
17	X	X	X	3	1.0
18	X	X	X	3	1.0
19	X	X	X	3	1.0
20	X	X	X	3	1.0
21	X	X	X	3	1.0
22	X	X	X	3	1.0
23	X	X	X	3	1.0
24	X	X	X	3	1.0
25	X	X	X	3	1.0
26	X	X	X	3	1.0
27	X	X	X	3	1.0
28	X	X	X	3	1.0
29	X	X	X	3	1.0
30	X	X	X	3	1.0
31	X	X	X	3	1.0
32	X	X	X	3	1.0
33	X	X	X	3	1.0
34	X	X	X	3	1.0

35	X	X	X	3	1.0
36	X	X	X	3	1.0
37	X	X	X	3	1.0
38	X	X	X	3	1.0
Item	Expert 1	Expert 2	Expert 3	Number in agreement	Item CVI
39	X	X	X	3	1.0
40	X	X	X	3	1.0
41	X	X	X	3	1.0
42	X	X	X	3	1.0
43	X	X	X	3	1.0
44	X	X	X	3	1.0
45	X	X	X	3	1.0
46	X	X	X	3	1.0
47	X	X	X	3	1.0
48	X	X	X	3	1.0
49	X	X	X	3	1.0
50	X	X	X	3	1.0
51	X	X	X	3	1.0
52	X	X	X	3	1.0
53	X	X	X	3	1.0
54	X	X	X	3	1.0
55	X	X	X	3	1.0
56	X	X	X	3	1.0
57	X	X	X	3	1.0
58	X	X	X	3	1.0
59	X	X	X	3	1.0
60	X	X	X	3	1.0
61	X	X	X	3	1.0
62	X	X	X	3	1.0
63	X	X	X	3	1.0
64	X	X	X	3	1.0
65	X	X	X	3	1.0
66	X	X	X	3	1.0
67	X	X	X	3	1.0
68	X	X	X	3	1.0
69	X	X	X	3	1.0
70	X	X	X	3	1.0
71	X	X	X	3	1.0
72	X	X	X	3	1.0
73	X	X	X	3	1.0
74	X	X	X	3	1.0
75	X	X	X	3	1.0
76	X	X	X	3	1.0
77	X	X	X	3	1.0

78	X	X	X	3	1.0
79	X	X	X	3	1.0
80	X	X	X	3	1.0
81	X	X	X	3	1.0
Item	Expert 1	Expert 2	Expert 3	Number in agreement	Item CVI
82	X	X	X	3	1.0
83	X	X	X	3	1.0
84	X	X	X	3	1.0
85	X	X	X	3	1.0
86	X	X	X	3	1.0
87	X	X	X	3	1.0
88	X	X	X	3	1.0
89	X	X	X	3	1.0
90	X	X	X	3	1.0
91	X	X	X	3	1.0
92	X	X	X	3	1.0
93	X	X	X	3	1.0
94	X	X	X	3	1.0
95	X	X	X	3	1.0
96	X	X	X	3	1.0
97	X	X	X	3	1.0
98	X	X	X	3	1.0
99	X	X	X	3	1.0
100	X	X	X	3	1.0

Appendix M.

Means and Standard Deviations by Gender for Attitude Items

Means and Standard Deviations by Gender for Attitude Items

Factor Areas	Male (n = 41)		Female (n = 50)		
	Mean	SD	Mean	SD	*p-value*
General Interest in Technology					
12. When something new is discovered, I want to know more about it immediately.	1.88	.900	1.98	.845	.579
17. I will probably choose a job in technology.	2.69	1.454	3.10	1.249	.266
18. I would like to know more about computers.	2.21	1.380	2.30	1.147	.691
22. I would not like to learn more about technology	4.13	1.260	3.64	1.191	.064
23. I like to read technology or technical magazines.	3.10	1.273	3.24	1.287	.660
28. I will not consider a job in technology.	3.77	1.202	3.38	1.369	.322
29. There should be less TV or Internet information about technology.	3.46	1.502	3.38	1.067	.758
32. I would rather not have technology lessons at school.	4.13	1.218	3.60	1.262	.144
33. I do not understand why anyone would want a job in technology.	4.15	1.113	3.82	1.335	.398
34. If there were a school club about technology I would certainly join it.	2.13	1.105	2.84	1.315	**.028**
38. Technology at home is something schools should teach about.	2.46	1.211	2.84	1.267	.150
39. I would enjoy a job in technology.	2.13	1.196	2.86	1.212	**.016**
44. I should be able to take technology as a school subject.	1.74	.910	2.16	1.283	.217
45. I would like a career in technology later on.	2.21	1.321	3.02	1.237	**.017**
46. I am not interested in technology.	4.26	1.093	3.52	1.374	**.017**
48. Using technology makes a country less prosperous.	3.62	.963	3.26	.965	.094
50. There should be more education about technology.	1.90	1.021	2.44	1.181	.071
Attitude Toward Technology					
51. Working in technology would be boring.	3.77	1.266	3.60	1.178	.482
52. I enjoy repairing things at home.	1.90	1.046	2.44	1.312	**.028**
53. More girls should work in technology.	2.62	1.184	2.90	1.216	.349
54. Technology causes large unemployment.	3.49	1.254	3.50	1.035	.959

56. Technology as a subject should be taken by all pupils.	2.87	1.174	3.10	1.147	.376
57. Most jobs in technology are boring.	4.00	1.192	3.88	1.100	.695
60. Because technology causes pollution, we should use less of it.	2.77	1.245	2.70	1.165	.756
	Mean	SD	Mean	SD	*p-value*
62. Technology lessons help to train you for a good job.	2.10	.882	2.28	.991	.599
63. Working in technology would be interesting.	1.90	1.165	2.14	1.010	.299
64. A technological hobby is boring.	4.18	1.097	3.76	1.271	.167
66. Technology is the subject of the future.	2.26	1.093	2.20	1.245	.717
68. Not everyone needs technological lessons at school.	2.31	1.195	2.40	1.245	.547
69. With a technological job your future is promised.	3.36	1.063	3.32	.978	.586
Technology as an Activity for Both Girls and Boys					
19. A girl can very well have a technological job.	1.44	.968	1.22	.616	.241
21. You have to be smart to study technology.	3.59	1.292	3.56	1.402	.930
24. A girl can become a car mechanic.	1.36	.707	1.34	.823	.993
26. Technology is only for smart people.	4.44	.788	4.54	.885	.666
30. Boys are able to do practical things better than girls.	3.90	1.119	4.66	.823	**.000**
35. Girls are able to operate a computer.	1.44	1.021	1.14	.452	.085
37. You have to be strong for most technological jobs.	3.90	1.071	3.70	1.329	.331
41. Boys know more about technology than girls do.	4.28	.972	4.74	.664	**.004**
43. To study technology you have to be talented.	3.77	1.158	4.12	1.206	.208
47 .Boys are more capable of doing technological jobs than girls.	4.23	1.087	4.60	.728	**.028**
49. You can study technology only when you are good at mathematics and science.	3.26	1.163	3.34	1.255	.748
Consequences of Technology					
14. Technology is good for the future of this country.	1.77	1.087	2.36	1.005	**.015**
15. To understand something of technology you have to take a difficult training course.	3.10	1.392	2.64	1.367	.163
16. At school you hear a lot about technology.	2.41	1.251	2.42	.950	.814
20. Technology makes everything work better.	2.82	1.144	2.94	1.150	.512
25. Technology is very important in life.	2.49	1.275	2.22	1.075	.233
27. Technology lessons are important.	2.03	.986	2.40	1.107	.183

31. Everyone needs technology.	3.74	1.446	3.48	1.092	.453
36. Technology has brought more good things than bad.	2.49	1.167	2.78	1.112	.157
42. The world would be a better place without technology.	3.82	1.189	3.64	1.102	.432
	Mean	SD	Mean	SD	*p-value*
Technology is Difficult					
59 .Girls prefer not to study technology or go to a career and technical school.	4.18	1.144	4.10	.974	.589
61. Everybody can study technology.	1.31	.800	1.32	.683	.859
65. Girls think technology is boring.	4.21	1.080	4.28	.948	.691
67. Everyone can have a technological job.	1.54	1.072	1.60	.926	.853

Appendix N.

Means and Standard Deviations by Gender for Concept Items

Means and Standard Deviations by Gender for Concept Items

	Male (n = 41)		Female (n = 50)		
	Mean	SD	Mean	SD	*p-value*
Component One					
71. I think science and technology are related.	1.59	.836	1.68	.891	.608
74. When I think of technology, I mostly think of equipment	1.76	.699	1.74	.751	.917
78. Working with information is an important part of technology.	1.49	.810	1.78	.932	.118
80. Elements of science are seldom used in technology.	2.27	.867	2.16	.792	.536
82. Technology has a lot of influence on people.	1.56	.838	1.54	.862	.907
83. I think technology is often used in science.	1.59	.836	1.60	.857	.935
84. Working with your hands is part of technology.	1.34	.656	1.26	.600	.538
87.Science and technology have nothing in common.	2.05	.631	2.14	.495	.442
88. The government can have influence on technology.	1.68	.907	1.58	.883	.586
89. I think the conversion of energy is also part of technology.	1.78	.936	1.92	.986	.494
91. Technology is meant to make our life more comfortable.	1.83	.834	1.70	.839	.465
94. Technology has always to do with mass production.	2.20	.843	2.30	.763	.535
99. Technology can mainly be found in industry.	1.88	.927	1.84	.817	.836
100. There is a relationship between technology and science.	1.49	.746	1.52	.814	.846
Component Two					
77. In technology, you can think up new things.	1.10	.436	1.10	.416	.978
81. You need not be technological to invent a new piece of equipment.	1.88	.842	1.64	.802	.172
85. In everyday life, I have a lot to do with technology.	1.56	.776	1.62	.805	.725
90. In technology, you use tools.	1.32	.722	1.22	.616	.491

92. When I think of technology, I mainly think of computer programs.	1.51	.675	1.70	.735	.212
93. Only technicians are in charge of technology.	2.22	.419	2.24	.476	.830
95. In technology, there are opportunities to do things with your hands.	1.29	.642	1.16	.510	.275
	Mean	SD	Mean	SD	*p-value*
96. Working with materials is an important part of technology	1.59	.865	1.58	.859	.976
97. Technology has little to do with daily life.	1.83	.667	1.88	.594	.702
98. When I think of technology I mainly think of working with wood.	2.15	.422	2.08	.396	.442
Did not load					
70. When I think of technology I mostly think of computers.	1.39	.628	1.44	.644	.712
72. In technology, you can seldom use your imagination.	1.78	.822	1.62	.830	.359
73. I think technology has little to do with our energy problem.	2.10	.768	1.96	.856	.427
75. To me technology and science are the same.	1.93	.685	2.02	.654	.510
76. In my opinion, technology is not very old.	1.63	.799	1.70	.735	.684
79. Technology is as old as humans.	2.10	.625	2.12	.558	.857
86. In technology, there is little opportunity to think up things yourself.	2.02	.652	1.94	.652	.540

Appendix O.

Qualitative Responses From Study Participants

A way to access things you can't access anywhere else
basicly any type of machine
invention that helps with laerining
technology means my life
like firefox and all
technology means to me a form of education formed by electricity power and software of information
Technology i think is something we use in everyday life and is very important to our human lives.Also,it is something we use in order to invent and build better and upgraded stuff.
Technology to me is a world where you can explore everything there is to explore.
Electronic console to do stuff differently
it is a way that this country is how it is
electricity based dodads
tells you a lot
Well, to me technology is we use now a days to help us and to play on and something u can use to improve your ideas
some thing that uses wifi
Technology makes new things by using electricity.
to give you information
Well, to me technology is stuff that people have created as an attempt to improve the world. Not just smart phones, but tools and duct tape.
electronics
Technology are things we use to make every day task easier. Usually technology is machines. Some examples of technology include smart phones and computers.
It means to me an improoved way of doing something
it means learning new stuff and sometimes you get to use technology to invent different stuff
machines that can help complete tasks faster [most of the time]
smart and a fast way to find stuff
It makes me feel happy
electrnics
It mean to me is learning
it takes creativity and heart. i love technology it is a big part in my life. i love to use tools with it and learning about it technology means a lot of things to me
The word technology to me means fun but not fun to me
phones,computer,internet.
I think that it is conputers tablets and soforth
Technology is any sort of device that has a screen with pixels.
I think technology's meaning is various to many people, but I think it kind of means: A newer way of doing things that might be very helpful in the long run.
An advanced way of progressing with normally a planned out format with normally some sort of machenery used or just a simple object
electronic programing/design
it means elctricity to me
computers,phones,tablets, etc.
it means ''smartness'' and i think technology is important.
complicated wired electronics
elctricity
help, searching, fun, answers, phones, electronics, information, hints
technology is stuff that program by it's self
a way to be able to create virtual fantasies or creating realistic or unrealistic ideas

it mean's "helpful
It is like a computer .
the word means to me is it can help you on what you need
It means to work on a device, like a computer. Or on the internet.
Technology is stuff that doesn't need to be programed when you buy it
computer wires connecting
The word means tome is phone and computer
future learning
some kind of advanced machine or type of device
i think it means to use the internet and like what you use for phones ipads laptops and computers
something that is powered by electricity.
computers, digital stuff, making stuff work
it means it uses the internet
it means something that wastes your money
Internet, Ultron, Google, and advanced medical technology
something to help you do something involving tech
complicated, screened devices
Technology means an electricity related item with a screen.
A study trying to make things more easier and more advanced
Technology is artificial intelengce. It is electronics;the power of electricty. It Is the fucher .
It means something that you put electricity into and you have created a screen for it to go on
machines or engineering
it means something that has a screen and has internet
computers, ipads, phones, t.v., smart board, cars,
I think technology is computers, electricity and the future.
To me "technology" means video games or TV, or in important ways doctor scans.
To me technology means something or somethings to help make something easer. Like cars make transpertation easer
COMPUTERS AND IPADS
IT MEAN NOTHING TO ME
To invent the future with electronic devices.
It means computers and electronics. Also it means future technology.
Mechanisms, and machines.
It is a device that does something. Sometimes it does something for you.
i think it is computers, ipods and other things. It is pretty much stuff with screens.s.
i think technology means like a computer ,iphones, tablets,any kind of devices.
mechcanacl and eletircal
ipad or computer
it means something that will forever develop to help or waste time, depending on how you use it.
technology is something that is a elctricity device.
i think it is computers, phones, tablets,and any elictricl divic
It means that is made of electricity.
building lektrouniks,working on cars and other things
stuff that can help you and other people
Technology is a object that involves electricity and it's manmade. I use a lot of technology and sometimes it is useful sometimes not to me. I think technology is supposed to help one's learning and to be used for help. Other than that I think that technology is used for things like houses,cars,games and other things like that. Also, I think technology is different programs used for almost anything.Thats what I think technology is used for/ or is.

electricity powered machines that are manmade and can be used to approve the way people around the world interact. technology does everything for us nowadays, and it shows how lazy we can be. but it also shows how smart a lot of us are. without technology the whole world would be unprepared. its actually a proven fact that most people are more prepared for a zombie apocylapse than if the whole world lost wifi
I think technology is a computer or an ipod. It is like something that you can connect with other people on. I think technology can be good or bad, the reason I think it is bad because it takes time away from being with others
I think it means electirual
Technology means using electricity to find out things in life
i think technology is certain thing us modern folks use as communication and learning

Appendix P.

Participants Qualitative Responses Categorized

Categories for Participant Responses

Student Responses (As written by students)	Abstract	Conceptual	Concrete	More than one
A way to access things you can't access anywhere else			1	
basicly any type of machine			1	
invention that helps with laerining		1		
technology means my life		1		
like firefox and all			1	
technology means to me a form of education formed by electricity power and software of information		1		
Technology i think is something we use in everyday life and is very important to our human lives.Also,it is something we use in order to invent and build better and upgraded stuff.	1	1		1
Technology to me is a world where you can explore everything there is to explore.		1		
Electronic console to do stuff differently			1	
it is a way that this country is how it is	1			
electricity based dodads			1	
tells you a lot	1			
Well, to me technology is we use now a days to help us and to play on and something u can use to improve your ideas		1		
some thing that uses wifi			1	
Technology makes new things by using electricity.		1	1	1
to give you information		1		
Well, to me technology is stuff that people have created as an attempt to improve the world. Not just smart phones, but tools and duct tape.		1	1	1
electronics			1	
Technology are things we use to make every day task easier. Usually technology is machines. Some examples of technology include smart phones and computers.		1	1	1
It means to me an improoved way of doing something		1		
it means learning new stuff and sometimes you get to use technology to invent different stuff	1	1		
machines that can help complete tasks faster [most of the time]				

	Abstract	Conceptual	Concrete	More than one
smart and a fast way to find stuff	1			
It makes me feel happy		1		
electrnics			1	
It mean to me is learning		1		
it takes creativity and heart. i love technology it is a big part in my life. i love to use tools with it and learning about it technology means a lot of things to me		1	1	1
The word technology to me means fun but not fun to me	1			
phones,computer,internet.			1	
I think that it is conputers tablets and soforth			1	
Technology is any sort of device that has a screen with pixels.			1	
I think technology's meaning is various to many people, but I think it kind of means: A newer way of doing things that might be very helpful in the long run.		1		
An advanced way of progressing with normally a planned out format with normally some sort of machenery used or just a simple object		1	1	1
electronic programing/design		1	1	1
it means elctricity to me			1	
computers,phones,tablets, etc.			1	
it means "smartness" and i think technology is important.	1			
complicated wired electronics			1	
elctricity			1	
help, searching, fun, answers, phones, electronics, information, hints		1	1	1
technology is stuff that program by it's self		1		
a way to be able to create virtual fantasies or creating realistic or unrealistic ideas	1			
it mean's "helpful		1		
It is like a computer.			1	
the word means to me is it can help you on what you need		1		
It means to work on a device, like a computer. Or on the internet.			1	

	Abstract	Conceptual	Concrete	More than one
Technology is stuff that doesn't need to be programed when you buy it			1	
computer wires connecting			1	
The word means tome is phone and computer			1	
future learning		1		
some kind of advanced machine or type of device			1	
i think it means to use the internet and like what you use for phones ipads laptops and computers			1	
something that is powered by electricity.			1	
computers, digital stuff, making stuff work		1	1	1
it means it uses the internet			1	
it means something that wastes your money		1		
Internet, Ultron, Google, and advanced medical technology			1	
something to help you do something involving tech		1		
complicated, screened devices			1	
Technology means an electricity related item with a screen.			1	
A study trying to make things more easier and more advanced		1		
Technology is artificial intelengce. It is electronics;the power of electricty. It Is the fucher .		1	1	
It means something that you put electricity into and you have created a screen for it to go on			1	
machines or engineering		1	1	
it means something that has a screen and has internet			1	
computers, ipads, phones, t.v., smart board, cars,			1	
I think technology is computers, electricity and the future.			1	
To me "technology" means video games or TV, or in important ways doctor scans.			1	
To me technology means something or somethings to help make something easer. Like cars make transpertation easer		1	1	
COMPUTERS AND IPADS			1	
IT MEAN NOTHING TO ME		1		
To invent the future with electronic devices.			1	

It means computers and electronics. Also it means future technology.		1	1	
	Abstract	Conceptual	Concrete	More than one
Mechanisms, and machines.			1	
It is a device that does something. Sometimes it does something for you.		1	1	
i think it is computers, ipods and other things. It is pretty much stuff with screens.s.			1	
i think technology means like a computer ,iphones, tablets,any kind of devices.			1	
mechcanacl and eletircal			1	
ipad or computer			1	
it means something that will forever develop to help or waste time, depending on how you use it.		1		
technology is something that is a elctricity device.			1	
i think it is computers, phones, tablets,and any elictricl divic			1	
It means that is made of electricity.			1	
building lektrouniks,working on cars and other things		1	1	1
stuff that can help you and other people		1		
Technology is a object that involves electricity and it's manmade. I use a lot of technology and sometimes it is useful sometimes not to me. I think technology is supposed to help one's learning and to be used for help. Other than that I think that technology is used for things like houses, cars, games and other things like that. Also, I think technology is different programs used for almost anything. Thats what I think technology is used for/ or is.		1	1	1
electricity powered machines that are manmade and can be used to approve the way people around the world interact. technology does everything for us nowadays, and it shows how lazy we can be. but it also shows how smart a lot of us are. without technology the whole world would be unprepared. its actually a proven fact that most people are more prepared for a zombie apocylapse than if the whole world lost wifi	1	1	1	1

I think technology is a computer or an ipod. It is like something that you can connect with other people on. I think technology can be good or bad, the reason I think it is bad because it takes time away from being with others		1	1	1
I think it means electirual			1	
	Abstract	Conceptual	Concrete	More than one
Technology means using electricity to find out things in life			1	
i think technology is certain thing us modern folks use as communication and learning		1		
Totals	9	40	61	14