THE DEVELOPMENT OF A VALID AND RELIABLE MEASURE OF TECHNOLOGICAL LITERACY FOR ADULTS

BY

SUSAN BASTION

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Chairperson – Dr. Bruce Frey

Dr. David Hansen

Dr. Steve Hillmer

Dr. Neal Kingston

Dr. Vicki Peyton

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The Dissertation Committee for SUSAN BASTION

certifies that this is the approved version of the following dissertation:

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Chairperson – Dr. Bruce Frey

Date approved:

Abstract

All people interact with technology on a daily basis. A technologically literate population is not only important for the individual, but also for businesses, organizations, and policy makers by supporting a modern workforce, enhancing social well-being, narrowing the digital divide, increasing citizen participation, and improving decision making (Pearson et al., 2002). The Standards for Technological Literacy, Characteristics of a Technologically Literate Citizen, and Characteristics of a Technological Literacy Person were utilized to develop a measurement tool designed specifically for technological literacy in adults.

Technological literacy was defined as including three dimensions (Knowledge, Capabilities, and Critical Thinking). These dimensions formed a conceptual framework which guided the development of a pool of potential items. Expert review and focus group feedback was used for revision. A sample of 208 Midwest college students enrolled in a general education technological literacy course responded to the items and also took two existing measures which assess similar constructs (the Survey of Technological Literacy and the Technology Inventory Profile). Analysis of their data guided final item selection and suggests that the new measure is valid and reliable. The Adult Technological Literacy Scale can be used for research, student placement, and course evaluation.

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Chapter 1: Introduction

Every day individuals and groups make choices concerning the use, management, and purchase of technology, but few are truly prepared to make sound decisions because they are not technologically literate. The early 80's saw the beginning of a critical shift from skill-based, vocational education to one focused on technological literacy due to the pervasiveness and diversity of technology in the world (National Science Board, 1983). This seismic shift is comparable to the industrial revolution in its impact on individuals, business and society.

Although many in today's society would define technology as computers, this is a very narrow perspective when considering the vast reality of the term "technology". By 1996, the term technological literacy was widely accepted to refer to a person's ability to use, manage, understand, and evaluate technology. (International Technology Education Association) The overall goal of technological literacy is to produce individuals with the conceptual understanding of technology and its place in society. These people can grasp and evaluate new technology that they may have never encountered. They can deal with complexity and in turn deal with our complex world especially when faced with unanticipated situations which often arise (Wladawsky-Berger, 2012). In essence, being technologically literate prepares people to function intelligently with current and future technology (Pearson et al., 2002).

Technologically literate people are prepared to interact with an ever changing world. They are more desirable employees, who will therefore earn a higher median wage than others who are not technologically literate (International Technology Education Association, 2005; Pearson et al., 2002; U.S. Department of Labor, 1999). This in turn, brings additional skills and capabilities to an employer. The employee's level of understanding has a positive impact on the business which improves the business's competitiveness in the global economy.

Successful businesses within the global economy can grow and provide support to society as a whole (National Academy of Engineering & National Research Council, 2006). The resulting security of employment and company growth supports consumer confidence and a more stable economy.

In a democratic society, such as the United States, the influence of a technologically literate person is more robust than in a more restrictive society due to the ability to influence decision making at all levels of the society. An individual, who is technologically literate, understands that technology is not a panacea. Not only does technological advancement solve problems, but it can also create new ones. Since technologically literate people generally experience improvements in thinking and decision making, this informed perspective influences what is developed and accepted in society (National Academy of Engineering & National Research Council, 2006).

Businesses and organizations benefit from a clear understanding of the general consensus of public understanding and perception of their technology. Policy makers can use information about technological literacy to guide policy decisions. Consequently, individuals who do not agree with adopted policy can use their influence to change policy makers (e.g. elect new representatives) or policy in general. The direct and indirect relationships between technological literacy and others provide a crucial insight into the importance of technologically literate citizens of the world.

Historically, the United States has valued the importance of science and engineering in the global economy (National Academy of Engineering, 2002; National Research Council 2005). Consequently, US colleges and universities offer technological literacy courses, and often require these types of courses as part of general education curriculum. While the implementation of programs related to STEM fields (science, technology, engineering, and mathematics), have extended the curriculum, the primary focus when assessing skills and competencies has been science and mathematics (Katehi et al., 2009). By ignoring the technology and engineering aspects of STEM areas, current measures are not providing a clear picture of the current state in the United States educational system. A need exists for a valid and reliable instrument for measuring the multi-dimensional construct of technological literacy. Previously, the development and administration of technological literacy measures have focused on school-aged (K-12) students. Specifically, middle school students have been the primary subjects for testing technological literacy (National Academy of Engineering & National Research Council, 2006).

Because standards for K-12 have been written, curriculum developed, and the subject matter is being taught, a comprehensive assessment of achievement is needed. In addition, there is an equally great need to measure technological literacy in the adult population which up to this point has been virtually ignored. The purpose of this study was to develop a measure of adult technological literacy. The primary focus is to ensure validity and reliability in the measurement of technological literacy for adults in the use, management, assessment and understanding of technology.

Chapter 2: Review of Literature

Technology is the “modification of the natural environment in order to satisfy perceived human wants and needs” (International Technology Education Association, 2000, p. 9). Definitions for technology may be found in many places such as the National Science Education Standards (National Research Council, 1996), Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993), and Standards for Technological Literacy (International Technology Education Association, 2000), but only slight variations in verbiage exist. Typically, technology is considered to have a physical aspect to the definition, like a “tool”. Technology impacts all walks of life, in all cultures, around the world. Although technology impacts human existence, few can actually define the term.

During a Gallup poll in 2004, a sample of 800 adults in the United States was asked “When you hear the word “technology”, what first comes to mind?” Sixty-eight percent of the respondents indicated “computers”. The next highest response was “electronics” at five percent (Rose et al., 2004). These responses would lead professionals in the field of technology education to conclude there is a disconnect between what the professionals and educators have defined technology to be, verses how the general population actually comprehends technology (Pearson et al., 2002). This indicates a need to not only identify the educational construct of technological literacy, develop educational standards for this construct, and instruct students in ways that meet the standards, but also measure student understanding and skills related to technological literacy.

Technological Literacy

Those who are technologically literate have the ability to participate in society intelligently and reasonably with regard to technology. Technologically literate people are an asset to any society. Technological literacy supports a modern workforce, enhances social well-being, narrows the digital divide, increases citizen participation, and improves the decision making, each of these benefits contributes to the argument for technological literacy and the need to identify those individuals who are technologically literate.

Supports a modern workforce. Much of the economic growth in the United States is driven by technology which has also led to an increase in the number of jobs requiring technological skills (Rausch, 1998). The increase of technological literacy among the potential workforce helps prepare these people for jobs in our technology driven economy. Trained workers have a broad range of knowledge and abilities. They are comfortable dealing with the technologies their jobs demand and find it easier to adapt to new technologies. As potential employees enter the workforce, those who are more technologically literate experience a competitive advantage in the job market and are more likely to receive higher compensation. Technological literacy has also been identified as an avenue to help compress the wage gap between salaried workers and their hourly counterparts without higher education (U.S. Department of Labor, 1999). Currently, the United States does not produce enough technically skilled workers for certain sectors of its high-tech economy which has forced a dependence on workers from other countries (Committee on Workforce Needs in Information Technology, 2001; 21st Century Workforce Commission, 2001). A technologically literate workforce is vital to the economic stability and growth of the United States.

Enhances social well-being. Technology is changing at an ever increasing rate. Being technologically literate is a tool people can use when adapting to the rapid changes around them. Those in society without these tools will struggle to maintain their positions which may result in a diminished sense of well-being and reduce their quality of life. Citizens who are technologically literate find it easier to understand and assimilate new technologies. They are less likely to stagnate. These people may feel empowered because they have the tools to make sense of their world as it evolves (Pearson et al., 2002).

Narrows the digital divide. The digital divide refers to the gap between those who have access to the internet and those who do not. Not only having access to the internet, but also the ability to use the internet impacts a person's access to information and therefore, influences one's technological literacy.

Of the 34.6 million households with no home internet access and/or no computer, 47% identify "no need or interest" as the primary reason for not having home internet access (Doms, 2011). Those who are not technologically literate, many times, do not realize the relevance of technology in their daily lives, which in turn, leads to greater illiteracy.

Additionally, the breath of the digital divide influences the gap between rich and poor, as well as the disparity between racial groups (Figure 2-1). Asian and White households more often subscribe to broadband service than Hispanic and Black households. The urban-rural divide can be seen with 70% of urban households having broadband to only 57% of rural households. It is within these groups were the digital divide is the most apparent (Doms, 2011).

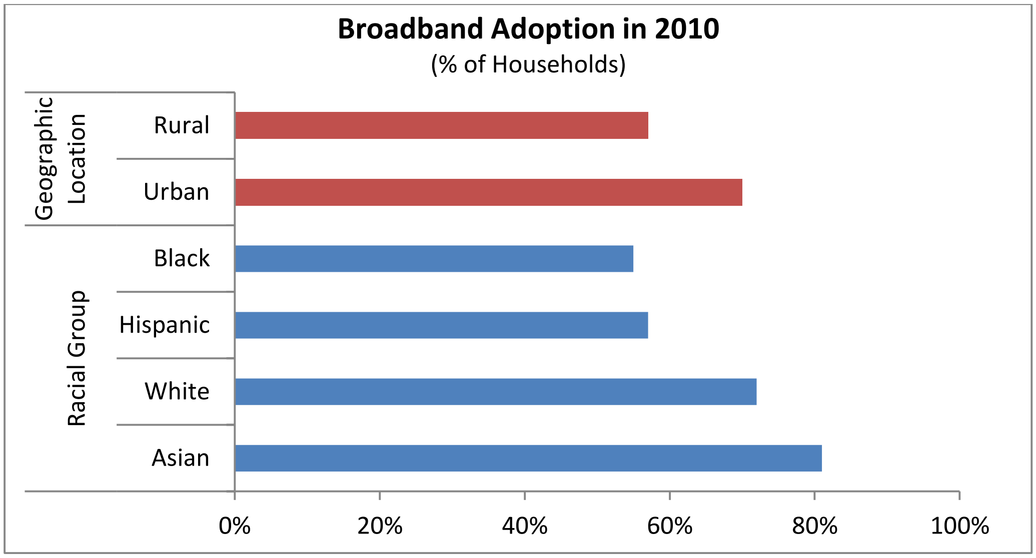


Figure 2-1. Bar graph showing percent of household adoption of broadband service by racial group and by geographic location in 2010.

Increases citizen participation. The founding fathers believed having an educated electorate was the cornerstone of democracy. As Americans, the citizens of the United States have not only a right but a duty to participate in all decisions related to society, including those about technology. “Most current political, legal, and ethical issues, from what to do about global warming to how to protect privacy in the Information Age, have a technological component.” (Pearson et al., 2002, p.36). Citizens who are technologically literate are more likely to fully participate in decision making. Decisions made without public input tend to be viewed as illegitimate and antidemocratic, which can impede the acceptance of technology (Pearson et al., 2002).

Technological literacy has benefits for society from the broadest sense to the most personal. Everyone can benefit from being technologically literate whether it is in their personal or professional lives. A technologically literate person is comfortable with technology and objective about its use, at the same time is not frightened nor infatuated with it (International Technology Education Association, 2000).

Improves decision making. As consumers, those citizens who are technologically literate may not know all of the advantages and disadvantages of the new technologies that emerge in the marketplace each year, but they do have the skills to learn enough about these products to make decisions about to use or not use it. In addition to personal decisions about technology, people in leadership positions make decisions daily that affect others. Decision makers with a higher level of technological literacy are "more likely to manage technological developments in a way that maximizes benefits to humankind and minimizes the negative impacts." (Pearson et al., 2002, p.26).

The importance of a technologically literate population has driven educators to develop standards for technological literacy which can be used in part or as a whole within each state's educational framework. In addition to including standards as part of the K-12 education, there is also a need to identify those in the adult population who are not technologically literate so that steps can be taken to resolve potential deficiencies which have detrimental effects on the population.

Standards for Technological Literacy

After the need to Technological Literacy was identified, the next task was to develop national standard. The Standards for Technological Literacy were adopted by the International Technology Education Association (currently International Technology and Engineering Education Association) in 2000. Over 4,000 people participated in the development and refinement of these standards during the three year process which included six drafts. Positive feedback during an extensive review process provided additional credibility to the Standards for

Technological Literacy. The standards focus on K-12 education and are organized in four broad areas (nature of technology, technology and society, abilities for a technological world, and the designed world). Specific benchmarks have been identified for various levels of education (K-2, 3-5, 6-8, and 9-12) with age and developmentally appropriate goals. Overall, there are 20 standards and 288 benchmarks distributed over the 4 grade categories (Table 2.1).

Table 2.1.

Standards for Technological Literacy Benchmark Distribution by Grade Level

Grade Level	K-2	3-5	6-8	9-12
Number of Benchmarks	43	58	86	101

Since the initial adoption of the Standards for Technological Literacy, they have been widely accepted by individual states. Only seven of forty-two (17%) state supervisors responding to a survey in 2011 indicated the Standards for Technological Literacy were not used in the state standards, curriculum guides, or state workshops regarding technology (Moye et al., 2012). In addition, 93% of the supervisors reported their states include some form of technology and/or engineering education, which is an increase from the 2001 report of 60% (Newberry, 2001). The movement of states to include technology and/or engineering as a content area further strengthens the need for effective measurement of the educational standards related to technology and technological literacy.

Evolution of Technological Literacy as a Construct

Technically Speaking (Pearson et al., 2002) was the precursor to Standards for Technological Literacy which provided a rational for the need for a technologically literate population. It also identified characteristics of a technologically literate person (CTLP):

- Familiarity with basic concepts important to technology (e.g. systems, engineering design processes, etc)
- Awareness of historical changes in society influenced by technology
- Understanding that society shapes technology as much as technology shapes society
- Evaluation of risks involved with the use or exclusion of technology
- Evaluation of costs and benefits related to technologies
- Ability to use quantitative reasoning skills
- Understanding that technology is neither good nor evil
- Comprehending that all technologies reflect society's culture and values
- Ability to perform hands-on capabilities with common every day technologies
- Participating responsibly in debates and discussions about technology.

This publication described technological literacy with dimensions of: knowledge, ways of thinking and acting, and capabilities. These three areas or dimensions were considered to be arbitrary divisions. It is impossible to separate one from another. With that in mind, the Standards for Technological Literacy were developed as previously noted.

Tech Tally (National Academy of Engineering & National Research Council, 2006) is the result of a two-year study intended to provide a "road map" for the assessment development of technological literacy. A committee of 16 experts on diverse subjects met seven times, sponsored one stakeholder workshop and spoke informally with nationally recognized experts on assessment, cognition, and related areas. The committee used *Technically Speaking* as a base for beginning the project. Specifically, the committee changed "ways of thinking" (terminology used in Technically Speaking) to " critical thinking and decision making" to more clearly describe the intent of being technologically literate and to eliminate the possible insinuation that people must adopt a particular view or position on a complex or controversial issue. In general, a technologically literate person has particular characteristics (See Table 2.2).

When comparing this list of characteristics of a technologically literate person and the Standards for Technological Literacy, there is significant overlap. Utilizing both allows for a more complete view of all aspects of technological literacy and a more accurate image of technological literacy as a construct.

Table 2.2:

Characteristics of a Technologically Literate Citizen

Knowledge • Recognizes the pervasiveness of technology in everyday life. • Understands basic engineering concepts and terms, such as systems, constraints, and trade-offs. • Comprehend with the nature of limitations of the engineering design process. • Knows some of the ways technology has shaped human history and how people have shaped technology. • Knows that all technologies entail risk, only some of which can be anticipated. • Appreciates that the development and use of technology involve trade-offs and a balance of costs and benefits. • Understands that technology reflects the values and culture of society.
Critical Thinking and Decision Making • Asks and answers pertinent questions, of self and others, regarding the benefits and risks of technologies. • Weighs available information about the benefits, risks, costs, and trade-offs of technology in a systematic way. • Participates, when appropriate, in decisions about the development and uses of technology.
Capabilities • Has a range of hands-on abilities, such as operating a variety of home and office appliances and using a computer for word processing and surfing the internet. • Can identify and fix simple mechanical or technological problems at home or at work • Can apply basic mathematical concepts related to probability, scale, and estimation to make informed judgments about technological risks and benefits. • Can use a design-thinking process to solve a problem encountered in daily life. • Can obtain information about technological issues of concern from a variety of sources

Source: Adapted from (Pearson et al., 2002)

Technological Literacy Measures

In 2002, Technologically Speaking recommended assessments be developed to measure technological literacy. The National Academy of Engineering and National Research Council of the National Academies committee on assessing technological literacy used a combination of formal (e.g. database searches) and informal (e.g., inquires of knowledgeable individuals and organizations) methods to identify assessment instruments previously utilized. This group believed that although the identified instruments should not be considered comprehensive, they had identified the most relevant. The resulting measures included those assessments designed to measure technological literacy, technological knowledge, or vocational aptitude. Few (eight) were designed specifically for adults (See Table 2.3). This same group argued that a generic instrument is not appropriate as the “level of technological literacy” changes; therefore it would not recommended to utilize an instrument designed for adolescents on an adult population (2006).

Two of the eight measures designed for adults (*Engineering K-12 Center Teacher Survey* and *Praxis Specialty Area Test: Technology Education*) were developed for K-12 teachers practicing in the United States in the field of technology education. The *Engineering K-12 Center Teacher Survey* measured attitudes, knowledge and interest about engineering. *The Praxis Specialty Area Test: Technology Education* was designed and administered to college education majors who wish to teach technology education at the middle or high school level. Specifically it measures pedagogical practices and knowledge in four areas of technology. Neither of these measures was designed for assessing technological literacy in the general population.

Table 2.3:

Technological-Literacy-Related Assessment Instruments (excerpt)

Test Name	Developer	Primary Purpose	Sample Question	Administration
K-12 Teachers				
Engineering K-12 Center Teacher Survey	American Society for Engineering Education	Inform outreach efforts of K-12 teachers	Indicate whether you strongly disagree, disagree, are neutral, agree, or strongly agree with the following statement: Engineering can be a way to help teach students language arts.	Continuously available
Praxis Specialty Area Test: Technology Education	Educational Testing Service	Teacher Licensing	The most important consideration in designing successful messages to be transmitted through graphic communications is knowledge and understanding of A. Current technologies B. The capabilities of the designer C. The estimated cost of the project D. The limitations of the printer. E. The nature of the audience	Regularly
Out of School Adults				
Armed Services Vocational Aptitude Battery	US Department of Defense	Assess potential of military recruits for job specialties in the armed forces and provide a standard for enlistment	Shock absorbers on a car connect the axle to the A .Wheel B. Chassis C. Drive shaft D. Exhaust pipe	Ongoing with revisions since 1968
Awareness Survey on Genetically Modified Foods	North Carolina Citizens' Technology Forum Project Team	Research on public involvements in decision making on science and technology issue	Ethical argument against the genetic modification of food products include: A. Genetically modified crops violate species integrity B. Biotechnology changes too fast to effectively understand and regulate it C. The belief that scientists should not "play God" D. All of the above E. I don't know	Once in 2001
Eurobarometer: Science and Technology	European Union Directorate General for Press and Communication	Monitor changes in public views of science and technology to assist decision making by policy makers	Mad cow disease (bovine spongiform encephalopathy) is due to the addition of hormones in cattle feed. (True/False/I don't know)	Surveys on various topics conducted regularly since 1973: polls specific to this topic were conducted in 2001, 2005, and 2010
European Commission Candidate Countries Eurobarometer: Science and Technology	Gallup Organization of Hungary, with funding from the European Commission	Monitor public opinion on science and technology issues of concern to policy makers	Antibiotics kill viruses as well as bacteria. (True/False/I don't know)	Periodically since 1973, this survey was administered in 2002
Gallup Poll on What Americans Think About Technology	International Technology Education Association	Determine public knowledge and perceptions of technology to inform to change and shape public views	When you hear the word "technology", what first comes to mind?	Twice, 2001 and 2004
Science and Technology: Public Attitudes and Public Understanding	National Science Board	Monitor public attitudes, knowledge, and interest in science and technology issues	Lasers work by focusing sound waves, true or false?	Biennually from 1979 to 2001.

The *Armed Services Vocational Aptitude Battery* (*ASVAB*), was developed specifically to measure aptitude of individuals with “sufficient skills and abilities to absorb military training, adjust to military life and become successful military members.” (ASVAB, n.d.). In its current form, the *ASVAB* contains eight subtests (Word Knowledge, Arithmetic Reasoning, Mechanical Comprehension, Shop and Automotive Information, Electronic Information, Mathematics Knowledge, General Science, and Paragraph Comprehension) (U.S. Department of Defense, 2012). Shop Information and Automotive Information although administered separately in the computerized adaptive test, are combined into a single score “AS”. The individual scores on Word Knowledge, Paragraph Comprehension, Arithmetic Reasoning, and Mathematics Knowledge are used to compute the Armed Forces Qualification Test (AFQT), which determines eligibility for enlistment. Although some areas of technology would be included in this test, it was not developed to measure technological literacy and is not appropriate to be used as such.

The *Awareness Survey on Genetically Modified Foods* conducted in North Carolina measured public perceptions about a very specific area of technology (Rocque-Romaine, 2003). Likewise, the European Commission periodically polls population samples of member and candidate countries to monitor public opinions about science and technology. Some of the questions contained in the surveys have measured specific areas of technological knowledge, but in general these instruments are focused on public opinion and perceptions; therefore, do not adequately measure technological literacy (European Commission, 2012).

In 2001 and again in 2004 the International Technology Education Association, with funding from the National Science Foundation and National Aeronautics and Space Administration conducted Gallup polls to measure public understanding, opinions, and attitudes about technology and technological literacy. The 2004 poll contained 16 questions which addressed 7 areas. Neither of these polls addressed higher order thinking. The International Technology Education Association reported responses may represent confidence rather than competence due to the format of the questions; therefore, these polls are not adequate for measuring technological literacy. (Rose & Duggar, 2002 and Rose et al., 2004)

American adults were surveyed in 2001 by the National Science Foundation interested in public attitudes and knowledge about science and technology. Since that time, additional reports have been published, but the 2001 data and alternative sources of information (Gallup polls, Eurobarometers and other sources) have been use. A majority of the questions on the survey related to attitudes and knowledge questions about science and did not require higher order thinking skills. As a technological literacy measure it is very limited due to the limited number of questions related specifically to technology, not just science.

After an extensive search and analysis of measure identified, no measures were identified as currently available to determine if the American education system is producing an adult population that is technologically literate.

Technological Literacy Models

Technological literacy is an important quality for the adult population. It has been adopted as a subject in general K-12 education. Although some attempts have been made to measure aspects of technological literacy in adults, current measures primarily focus on opinion or extremely limited subject matter; therefore, the need exists to develop an instrument to measure technological literacy in the adult population.

In 2002, technological literacy's three dimensions where graphically represented as Figure 2-2 (Pearson et al., p15). The areas of knowledge, capabilities, and ways of thinking and acting are identified with levels for each dimension. This representation does not provide illustration for the interaction between each dimension. Interpretation of this model can be confusing. It illustrates low, limited, poorly developed as all occurring simultaneously and high, extensive, highly developed as separate and independent.

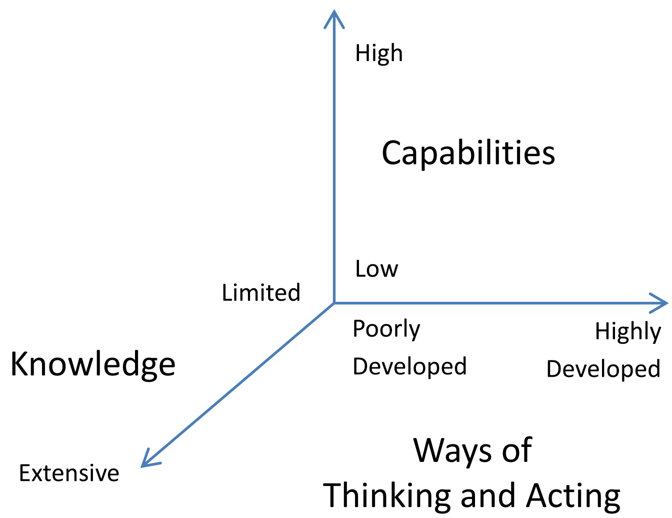


Figure 2-2: Graphical representation of Technological Literacy (Pearson et al., 2002)

Over time, National Academy of Engineering & National Research Council redesigned the model to be illustrated as interconnected links as seen in Figure 2-3 (2006). They realized the major commonality across definitions of technological literacy; it is multidimensional and complex. Although the model was published as interconnecting links, they also stated, there are a number of ways to depict the interrelatedness of the components.

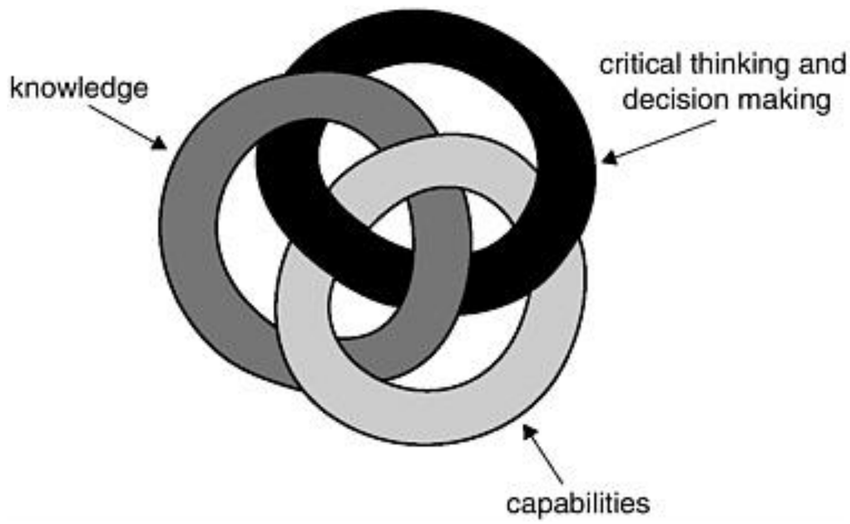


Figure 2-3: Graphical representation of Technological Literacy-revised (National Academy of Engineering & National Research Council, 2006)

By illustrating a model for technological literacy as overlapping ovals, it more clearly relates the interaction of the three dimensions (Figure 2-4). *Tech Tally* specifically states "A person cannot have technological capabilities without some knowledge, and thoughtful decision-making cannot occur without an understanding of some basic features of technology. The capability dimension, too, must be informed at some level by knowledge. Conversely, the doing component of technological literacy invariably leads to a new understanding of certain aspects of the technological world." (National Academy of Engineering & National Research Council, 2006, pp37-38). This specific depiction of the model also illustrates varying degrees of technological literacy through color intensity (the more intense the color, the greater the degree of technological literacy).

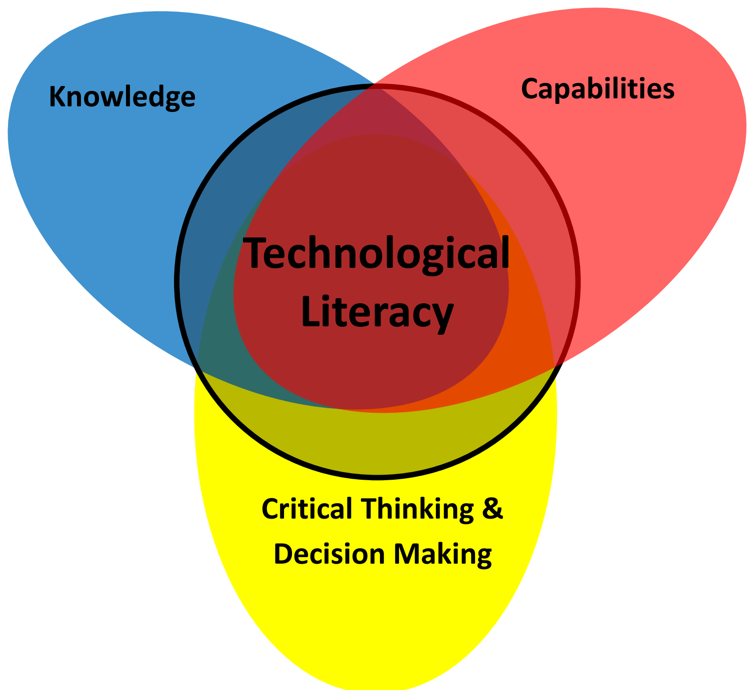


Figure 2-4: Three Dimensions of Technological Literacy Model

Technological literacy includes knowledge, capabilities, and critical thinking skills needed to be a contributing member of society in the United States. The wide spread adoption of technological literacy as a content area in K-12 education has resulted in the need to measure the success of the education system to prepare students for the future world in which they will live. The Standards for Technological Literacy, characteristics of technologically literate persons, and the technological literacy model all have vital roles to play in the development of a measure to accurately quantify technological literacy in the post-secondary population of the United States. Measurement will allow documentation adult preparedness; therefore, a measurement tool is a necessity.

Chapter 3: Methods

The goal of this study was the development of an assessment for technological literacy in the post-secondary adult population. The assessment provides information about the three areas (knowledge, critical thinking and decision making, and capabilities) which have been identified in the Three Dimensions of Technological Literacy Model as the primary components of technological literacy (Figure 2-4).

Participants

Human subjects approval. Approval for this study was obtained from the human subjects committee (HSCL) of the University of Kansas and Pittsburg State University. No unusual or extreme hardship was experienced by participants in this study. Respondents were students enrolled in the general education class called Introduction to Technological Systems offered at Pittsburg State University. The only demand on the respondents was the time necessary to complete an online and a hard copy of a set of questions regarding their knowledge, capabilities and critical thinking as they relate to technological literacy. In exchange for their participation, respondents received extra credit points which were applied to their overall grade in the course.

Sample. During the Spring 2014 semester at Pittsburg State University, a total of 249 students were enroll in 6 sections of GT190: Introduction to Technological Systems. Of the students enrolled, 208 (83.5%) participated in the study.

Demographics. The participants were 110 women (52.9%) and 98 men (47.1%) college students who were over 18-years of age. Most of the respondents were classified as freshmen (*n=83, 39.9%)* or sophomore students (*n=67, 32.2%).* The remainder of the respondents were junior (*n=32, 15.4%)*, senior *(n=24, 11.5%)* or graduate students (*n=2, 1.0%).*

The respondents were a diverse group in terms of their area of study, including undeclared *(n=33, 15.9%)* and those majoring in degrees from all four of the colleges (Arts & Sciences, Business, Education, and Technology) within the Pittsburg State University academic structure. The College of Arts & Sciences degrees were the most common with the respondents *(n=94, 45.2%).* Forty-three respondents *(20.7%)* were pursuing degrees in the College of Technology. The remaining students were majoring in degrees from the College of Education *(n=34, 16.3%),* College of Business *(n=4, 1.9%)*, or were undeclared *(n=33, 15.9%).*

Most of the respondents reported having never taken a class related to technology (61.5%). Some indicated taking only one class focusing on technology (24%). The remaining respondents reported taking 2, 3 or 5 (7.7%, 2.9%, and 1.4% respectively) technology classes prior to enrollment.

Construct Defined

As previously identified, technological literacy refers to one's ability to use, manage, assess and understand technology. The broad definition has been further clarified to contain three dimensions (knowledge, critical thinking/decision making, and capabilities) as illustrated by the Three Dimensions of Technological Literacy Model (Figure 2-4) which is based on the information identified in the literature review.

Much work has been done by the International Technology and Engineering Education Association to not only define technology and technological literacy, but to then use these terms and concepts to further clarify the construct of technological literacy. As previously noted, the association has developed national standards and benchmarks for technological literacy to be used as a framework in the K-12 classroom (International Technology Education Association, 2007). A comparison of the technological literacy standards, characteristics and a technologically literate person and the characteristics of a technologically literate citizen (see Table 3.1) indicate there are similarities across all three documents. In some instances the three lists are in harmony and obviously refer to exactly the same concept (e.g. Understand the influence of technology on history – Awareness of historical changes in society influenced by technology – Knows some of the ways technology has shaped human history and how people have shaped technology). In other cases the different lists provide additional clarification, for example "Understand basic engineering concepts and terms such as systems constraints and trade-offs" is more descriptive than "Familiarity with basic concepts important to technology (systems, engineering design process)", but additional information is provided by "Knows the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving". The characteristics for a technologically literate citizen was used as the primary source for the table of specifications with the other lists providing supplementary explanations as needed.

Table 3.1:

Comparison of Technological Literacy Standards, Characteristics of a Technological Literate Person and Characteristics of a Technological Literate Citizen

<table>
<tr><th>Dimen-
sion</th><th>Technological Literacy Standards
(ITEA, 2007)</th><th>Characteristics of a
Technologically Literate Person
(Pearson et al., 2002)</th><th>Characteristics of a
Technologically Literate Citizen
(NAE & NRC, 2006)</th></tr>
<tr><td rowspan="5">Knowledge</td><td>Acquiring knowledge of the characteristics and scope of technology</td><td rowspan="5">Familiarity with basic concepts important to technology (systems, engineering design process, etc)</td><td>Recognizes the pervasiveness of technology in everyday life.</td></tr>
<tr><td>Acquiring knowledge of the core concepts of technology</td><td rowspan="3">Understands basic engineering concepts and terms, such as systems, constraints, and trade-offs.</td></tr>
<tr><td>Knows the role of troubleshooting, research and development, inventions and innovation, and experimentation in problem solving</td></tr>
<tr><td>Knows the attributes of design and engineering design</td></tr>
<tr><td></td><td>Is familiar with the nature of limitations of the engineering design process.</td></tr>
</table>

Table 3.1 (continued):

Knowledge	Understands the effects of technology on the environment		Knows that all technologies entail risk, only some of which can be anticipated.
			Appreciates that the development and use of technology involve trade-offs and a balance of costs and benefits.
	Understand the influence of technology on history	Awareness of historical changes in society influenced by technology	Knows some of the ways technology has shaped human history and how people have shaped technology.
	Understand the role of society in the development and use of technology	Understanding that society shapes technology as much as technology shapes society	
		Comprehending that all technologies reflect society's culture and values.	Understands that technology reflects the values and culture of society.
	Acquiring knowledge of the relationships among technologies and the connections between technology and other fields		
	Understands the cultural, social, economic, and political effects of technology		
Critical Thinking & Decision Making		Participating responsibility in debates and discussion about technology	Asks pertinent questions, of self and others, regarding the benefits and risks of technologies.
			Participates, when appropriate, in decisions about the development and uses of technology.
	Assess the impact of products and systems	Evaluation of risks involved with the use or exclusion of technology	Weighs available information about the benefits, risks, costs, and trade-offs of technology in a systematic way.
		Evaluation of costs and benefits related to technologies	
Capabilities	Develop an understanding of selecting and using: • medical technologies • agricultural and related technologies • energy and power technologies • information and communication technologies • transportation technologies • manufacturing technologies • construction technologies	Ability to perform hands-on capabilities with common every day technologies	Has a range of hands-on abilities, such as operating a variety of home and office appliances and using a computer for word processing and surfing the internet.
	Can use and maintain technological products and systems		Can identify and fix simple mechanical or technological problems at home or at work
		Ability to use quantitative reasoning skills.	Can apply basic mathematical concepts related to probability, scale, and estimation to make informed judgments about technological risks and benefits
	Apply the design process		Can use a design-thinking process to solve a problem encountered in daily life.
			Can obtain information about technological issues of concern from a variety of sources.

Measures

In addition to the questions developed for this study, two previously existing measures were selected to for comparison. One measure, Survey of Technological Literacy, was developed to measure student progress toward technological literacy as a result of completing a general education course at Old Dominion University (Ritz, 2011). The other measure was designed to assess technological literacy in upper secondary schools (Luckay & Collier-Reed, 2014). These measures, although developed for different initial uses are both similar in some aspects to the construct of interest, technological literacy.

Table 3.2:

Survey of Technological Literacy Question Distribution

Impacts of Technology	Technology Working Knowledge	Career Decisions
5 questions	17 questions	5 questions

Survey of Technological Literacy. The developer of this survey defined technological literacy "traits" with broad categories of knowledge, ways of thinking and acting, and capabilities. Primarily developed to assess student growth after completing the general education course - *Technology in Your World* and focused on the general education goal of Old Dominion University, the *Survey of Technological Literacy* identified technological literacy with three areas of interest: 1) impacts of technology, 2) technology working knowledge, and 3) career decisions. The survey consists of 27 questions each using a 5-point Likert scale (Strongly Agree, Agree, Uncertain, Disagree, and Strongly Disagree) distributed between these 3 areas (Table 3.2). For this study, the career decisions questions were not utilized because these questions did not apply to the Table of Specification used when developing new measure. No reliability nor validity statistics were reported for this instrument (Ritz, 2011)

Technology Profile Inventory. The Technology Profile Inventory survey was developed with holistic view of technological literacy which identifies "understanding the nature of technology, having a hands-on capability and capacity to interact with technological artifacts and be able to think critically about issues related to technology" as the focus of instrument development (Luckay & Collier-Reed, 2012). A factor analysis of the items in the instrument identified five areas: artifact, process, direction/instruction, tinkering, and engagement. The survey includes a total of 29 questions distributed among seven sub-scales (Appendix B). Internal reliability ranges across sub-scales from α=.55 (engagement) to α=.83 (direction/instruction).

Table 3.3:

Technology Profile Inventory Question Distribution with Reliability

Category	Scale	Number of Items	Cronbach alpha	% Variance	Eigenvalue
Nature of Technology	Artifact	5	.61	7.11	2.14
	Process	8	.67	10.52	3.16
Interacting with a Technological Artifact	Direction/Instruction	8	.83	18.81	5.05
	Tinkering	3	.66	5.17	1.55
	Engagement	5	.55	4.25	1.28

(Luckay & Collier-Reed, 2014)

GT190 Course Final Fall 2013. At the beginning of each semester, students enrolled in GT190: Introduction to Technological Systems complete a pre-test for the course. This pre-test is the previous semester's final. The questions on the final are a combination of newly developed questions piloted during the semester and questions from banks which have been revised over the last 5 years.

After the construct of technological literacy was defined, the following steps were utilized to develop the final measure:

1. Generated items
2. Determined measure format
3. Reviewed initial pool
4. Administered to development sample
5. Evaluated items
6. Optimized scale length

These steps provided the pathway to the development of the final instrument.

Instrument Development

Generated Items. Once the construct was defined utilizing the models, characteristics, and standards identified in the literature, items were generated. During item generation for this measure (Adult Technological Literacy Scale), the primarily focus was the purpose of the instrument (DeVellis, 2012). Utilizing the comparison of the characteristics and the standards helped focus item writing on the construct and dimensions of interest and aided in content as well as face validity (Netemeyer et al., 2003).

Many professionals in the field of measure development suggest considerations when writing items for a scale. Clarity was a focus when writing items. Specifically, pitfalls avoided included unnecessarily length, excessively complex vocabulary, and ambiguously referenced pronouns (DeVellis, 2012 and Netemeyer et al., 2003). Additional item writing guidelines identify by Fowler (1995) were utilized when appropriate.

The items were developed utilizing the Table of Specification (Table 3.4). A target of 90-120 items (6-10 items per operationalization) was the goal for the initial item pool. DeVellis stated that it is “impossible to specify the number of items that should be included in the initial pool”, but due to technological literacy being a multifaceted construct 90-120 items was a realistic target (2012). It was important to constrain the number of items so that they may be administered efficiently to the group of subjects. A total of 111 items were developed. The distribution of the developed questions between the dimensions and operationalization can be found on Table 3.4. The generation of the items led to the determination of the measure format, which was the next step in the process.

Table 3.4:

Table of Specifications for Technological Literacy Measure Including Number of Items Developed

Dimension	Operationalization	# of Items (Target)	# of Items Developed
Knowledge	Recognizes the pervasiveness of technology in everyday life.	3-5	8
	Understands basic engineering concepts and terms, such as systems, constraints, and trade-offs.	3-5	7
	Knows that all technologies entail risk, only some of which can be anticipated.	3-5	7
	Knows some of the ways technology has shaped human history and how people have shaped technology.	3-5	7
	Understands that technology reflects the values and culture of society.	3-5	7
Critical Thinking & Decision Making	Asks pertinent questions, of self and others, regarding the benefits and risks of technologies.	3-5	9
	Weighs available information about the benefits, risks, costs, and trade-offs of technology in a systematic way.	3-5	7
Capabilities	Has a range of hands-on abilities, such as operating a variety of home and office appliances and using a computer for word processing and surfing the internet.	3-5 (Multiple Choice) 3-5 (Likert scale)	8 (Multiple Choice) 7 (Likert scale)
	Can identify and fix simple mechanical or technological problems at home or at work	3-5 (Multiple Choice) 3-5 (Likert scale)	7 (Multiple Choice) 7 (Likert scale)
	Can apply basic mathematical concepts related to probability, scale, and estimation to make informed judgments about technological risks and benefits	3-5 (Multiple Choice) 3-5 (Likert scale)	8 (Multiple Choice) 7 (Likert scale)
	Can obtain information about technological issues of concern from a variety of sources.	3-5 (Multiple Choice) 3-5 (Likert scale)	7 (Multiple Choice) 8 (Likert scale)

Determined measure format. The group of items generated, based on the construct defined, were grouped by specific dimension of technological literacy. Each of the dimensions of technological literacy lent itself to specific measure formats. Due to the inherent right/wrong of knowledge questions, the knowledge dimension utilized objective based, multiple choice questions. All of the questions for the knowledge dimension were developed to have five possible responses (one correct answer with four distractors). The number of distractors decreased the possibility of the subject guessing the correct response.

Given the difficulty of accurately measuring critical thinking/decision making type questions, a self-evaluation Likert-scale was used record subject responses. Each question was designed to have five response options. The questions were worded in such a way to provide equal intervals between the pairs of responses as well as to differentiate between opinions (DeVallis, 2012).

The questions for the capabilities section includes two parts each with a different format. The first part includes scenario type items with multiple-choice questions with five possible responses (one correct answer with four distractors). The second part is comprised of self-evaluation Likert-scale items with five possible responses similar to the critical thinking/decision making questions.

Reviewed of initial pool. Once the item pool had been generated, the next step was to have a group of experts and potential respondents review the items. Each of these groups offered insight to improve the measure prior to being distributed to the sample.

The expert panel consisted of a certified technology education teacher (involved with developing the Standards for Technological Literacy), a certified K-12 teacher with experience writing curriculum to meet specific math, reading, and gifted education standards, and an administrator with expertise in technology education (including a PhD in Technology Education). This diverse group provided a variety of perspectives.

The experts rated the items based on the item measuring the desired operationalization. A rating sheet was provided which encompassed the dimension to be measured, the operationalization corresponding to the dimension, a rater response selection (Yes, No, Maybe), the question text, and a comment section (See example: Table 3.5). Questions with complete "Yes" agreement between all raters were included in the pool for the next step in the process. Questions with universal "No" ratings were be dropped from the item pool. A group discussion was held to review those questions without complete consensus to determine if the question should be reworked to measure the intended dimension and operationalization or if the question should be dropped from the item pool. Each expert was also asked to identify ways of tapping into the phenomenon that were not included in the item pool (DeVellis, 2012).

Table 3.5:

Example of Expert Rater Feedback Sheet

<table>
<tr><th>Dimension</th><th>Operationalization</th><th>Does the question measure the dimension and operationalization?</th></tr>
<tr><td>Knowledge</td><td>Recognizes the pervasiveness of technology in everyday life.</td><td>Yes Maybe No</td></tr>
<tr><td colspan="3">Select the best answer to complete the following statement:
Technology is _____.
A) applied science
B) the study of the natural world as it relates to humankind
C) the use of computers and electronic media to assist individuals in the learning process
D) the generation of knowledge and processes to solve problems and extend human capabilities
E) any device that moves and requires electrical power to operate, whether it is computer-related or not.</td></tr>
<tr><td colspan="3">Comment:</td></tr>
</table>

The group of experts did not reach consensus on four questions from the item pool. It was agreed upon that three of the questions should be removed. The three experts reached consensus to include the remaining questions (K2-1, K5-5, and CT1-2) with the changes identified in Table 3.6. The slight change to punctuation in question K2-1 clarified “plastic, electronic components and a laser” were parts of the computer mouse. No suggested additions or alternative questions to the item pool were offered by the group. One distractor in question K5-5 was simplified. The wording was considered confusing and unnecessarily complicated. Question CT1-2 was changed to reflect first person which was the format of the Likert-scale questions. The experts also believed the addition of “based on a news clip” provided additional restriction to information used to make a particular decision.

Table 3.6:

Question Changes Based on Expert Group Review

Original Question	New Question
K2-1: All technologies can be described using the universal systems model illustrated below. <Image omitted> Considering the technology of a computer mouse; plastic, electronic components, and a laser would all be examples of which part of the system?	K2-1: All technologies can be described using the universal systems model illustrated below. <Image omitted> Considering the technology of a computer mouse - plastic, electronic components, and a laser would all be examples of which part of the system?
K5-5: Select the best answer for the following question: The development of life supporting technologies (example: respirators and feeding tubes) has resulted in _____. A) values conflicts between two or more cherished values of one and the same party.. B) economic conflicts. C) societal conflicts between minority groups. D) endangerment conflict without prior consent. E) a variety of conflicts both economic and values based.	K5-5: Select the best answer for the following question: The development of life supporting technologies (example: respirators and feeding tubes) has resulted in _____. A) values conflicts B) economic conflicts C) societal conflicts between minority groups. D) endangerment conflict without prior consent. E) a variety of conflicts both economic and values based.
CT1-2: The current research indicates a new technology will eradicate heartworms in dogs; therefore, you adopt this new technology. A) Strongly agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	CT1-2: The current research indicates a new technology will eradicate heartworms in dogs; therefore, I will adopt this new technology based on a news clip. A) Strongly agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree

The aforementioned changes and deletions were made prior to providing the question bank to a groups of college students who would potentially fit into the population of interest. The group of college students used to evaluate the potential items included a freshman education major-male, freshman biology major-female, sophomore graphics major-female, and junior automotive technology major-male. These students were directed to focus on potential clarity or conciseness issues utilizing a rater form (see example: Table 3.7). Questions with complete "Yes" agreement between all raters were added to the pool, while questions with universal "No" ratings will be dropped. A group discussion was be held to review the questions without complete consensus to determine if the question could be reworked to improve clarity or if the question should be dropped from the item pool.

Table 3.7:

Example of Student Rater Feedback Sheet

Do you understand what the question is asking?	*Is the question clear?*	*Do you believe the question is concise?*
Yes No Maybe	Yes No Maybe	Yes No Maybe
Select the best answer to complete the following statement: Technology is _____. A) applied science B) the study of the natural world as it relates to humankind C) the use of computers and electronic media to assist individuals in the learning process D) the generation of knowledge and processes to solve problems and extend human capabilities E) any device that moves and requires electrical power to operate, whether it is computer-related or not.		
Comment:		

The group of students identified questions three questions. Question K1-6 is very similar to K1-7. The students unanimously preferred K1-7; therefore K1-6 was removed from the item pool. Similarly, K1-8 and K1-1were alike. The students favored K1-1, which resulted in K1-8 being eliminated from the question bank. Two of the student evaluators noted that question

C(L)4-4 was "unclear" or "confusing". The entire group agreed upon rewording the question stem from:

> "RFID (Radio Frequency Identification) are devices that have been implanted in some credit/debit cards to allow for faster checkout from a retail establishment. I would research this to determine the security of these devices prior to use."

to:

> "RFID (Radio Frequency Identification) devices have been implanted in some credit/debit cards. This technology can allow for faster checkout from a retail establishment. Prior to using this technology, I would research potential security issues."

The review by an expert panel and a focus group resulted in a more valid instrument. After the expert and student panels reviewed the questions, remaining 107 questions were administered to the development sample.

Administered to development sample. The assembled measure and two validating instruments (Technology Profile Instrument and technological literacy survey from Old Dominion University) were administered to the development sample utilizing CANVAS (an open source learning management system used at Pittsburg State University). The third instrument, G190: Introduction to Technological Systems Final Exam Fall 2013 was administered as a hard copy, in-class to all students at the beginning of the Spring 2014 semester.

The questions to be administered on-line (Technology Profile Instrument, Survey of Technological Literacy, and Adult Technological Literacy Scale) were entered into Canvas as three separate question banks. The question banks were then used to compile an instrument for each student. The question order (within each measure) and the responses for each question were randomized at the individual test-taker level.

A link was created to aid respondents in accessing the instrument on Canvas. This link was provided to the students in an announcement placed within the course on Canvas and in a group email sent to all students currently enrolled in the course. An additional verbal announcement was made in class to remind students to check emails and “Announcements” on Canvas for an extra credit opportunity. The respondents were given two weeks to complete all of the questions provided. Those who completed the questions received 25 extra credit points which was added to the course grade.

Chapter 4: Results

After the two-week window for completion, all resulting information was transferred into an SPSS file. Items were examined for negative discrimination and *Cronbach's Alpha* was used to adjust scale length. The resulting total and sub-scales were compared to existing measures of technological literacy.

Analyzed items. At this point in the process, the measure had been compiled and administered to the sample group, so the next step was to utilize the data gathered to evaluate the items. Each sub-scale (Knowledge, Capabilities-Scenario, Capabilities-Likert, and Critical Thinking/Decision Making) was analyzed separately. Question C(S)3-2 produced a negative item discrimination ($\rho = -0.07$) and was removed prior to additional analyses being completed.

Optimized scale length. The determination of sub-scale length was based on *Cronbach's Alpha if Item Deleted.* For three of the four sub-scales (Knowledge, Capabilities-Scenario, and Critical Thinking) items negatively affecting reliability were removed, one at a time (Appendix C). Sub-scale: Knowledge originally included 33 items with an initial reliability of α=.64. After reducing the number of questions to 18, the reliability was maximized at α=.68 (see Table 4.1). Originally, the Capabilities-Scenario sub-scale included 30 questions resulting in an α=.68. The reduction to 18 questions increased the reliability to .72. Capabilities-Likert subscale initially started with a "high" reliability (α=.86). In this case, to shorten the instrument, the number of questions were reduced to 11 without drastically effecting the reliability (α=.81). In the beginning, the last sub-scale, Critical Thinking, originally consisted of 16 questions with a reliability of .54. These questions were compressed to only 7 resulting in an increased reliability to .62.

Table 4.1:

Sub-Scale Number of Items and Reliability

Sub-scale	**Initial # of items**	**Initial α**	**Final # of items**	**Final α**
Knowledge	33	.64	18	.68
Capabilities-Scenario	30	.68	18	.72
Capabilities-Likert	29	.86	11	.81
Critical Thinking	16	.54	7	.62

Descriptives

All four measures included responses from a total of 208 subjects. The Adult Technological Literacy Scale produced the highest total mean of 95.04 (*SD*=12.31) out of a total of 126 points. The individual sub-scales within this measure produced mean values which ranged from 10.89 (Knowledge) to 43.00 (Capabilities-Likert) and standard deviations ranging from 3.07 (Knowledge) to 6.92 (Capabilities-Likert). The sub-scale total score possible ranged from 18 (Knowledge and Capabilities-Scenario) to 55 (Capabilities-Likert)

The responses on Technology Profile Inventory developed at University of Cape Town generated the second highest mean of 87.58 (*SD=10.42)*. The five sub-scales varied in mean score from 28.76 (SD=5.03) for Processes to 7.53 (SD=1.53) on Tinkering. The variation can be attributed to the difference in number of questions within each subscale. The subscale of Processes included 8 questions on a 5-point scale (possible total score of 40), where Tinkering only included 3 questions on the same 5-point scale (Table 4.2).

The Survey of Technological Literacy measure consisted of the highest possible score (135), but only resulted in a total mean of 85.10 (*SD=9.06).* The mean on the Technology Knowledge subscale (65.96) was the highest of all sub-scales analyzed regardless of measure, but is related to the number of questions, 17, which results in a total possible score of 85 on this particular subscale (Table 4.2).

The Fall 2013 Final Exam consisted of the most questions, 100, but produced the lowest possible score of 100 points. The mean for this measure calculated to be 45.30 (*SD=11.23).* Compared to the other measures, this exam generated the lowest mean and the second highest standard deviation (Table 4.2).

Table 4.2:

Descriptive Statistics for Adult Technological Literacy Scale, Survey of Technological Literacy, Technology Profile Inventory, and Final Exam

	Score points possible	***N***	***Mean***	***St. Dev.***
ATLS Total	*126*	*208*	*95.04*	*12.31*
ATLS: Knowledge	*18*	*208*	*12.12*	*3.07*
ATLS: Capabilities-Scenario	*18*	*208*	*10.89*	*3.34*
ATLS: Capabilities-Likert	*55*	*208*	*43.00*	*6.92*
ATLS: Critical Thinking	*35*	*208*	*29.04*	*3.65*
STL: Total	*110*	*208*	*85.10*	*9.06*
STL: Impacts of Technology	*25*	*208*	*19.16*	*2.54*
STL: Technology Knowledge	*85*	*208*	*65.96*	*7.30*
TPI: Total	*145*	*208*	*87.58*	*10.42*
TPI: Artifact	*25*	*208*	*12.16*	*4.03*
TPI: Processes	*40*	*208*	*28.76*	*5.03*
TPI: Engagement	*25*	*208*	*18.40*	*2.70*
TPI: Directions	*40*	*208*	*20.72*	*6.03*
TPI: Tinkering	*15*	*208*	*7.53*	*1.55*
Fall 2013 Final Exam	*100*	*208*	*45.30*	*11.23*

Sub-Scales

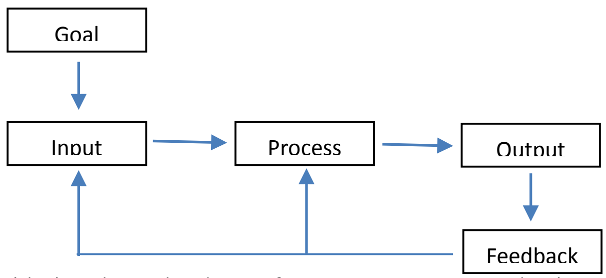
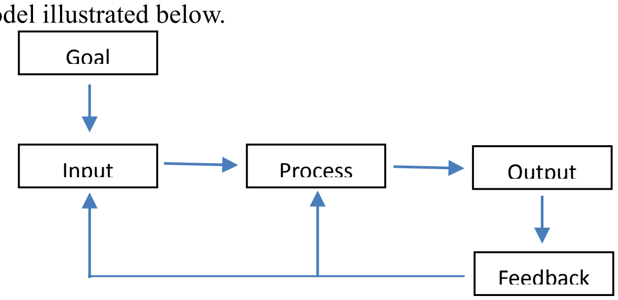
Knowledge. The sub-scale Knowledge includes a total of 18 questions resulting in a mean score of 12.12 (*SD*=3.07). The item difficulties within the Knowledge sub-scale range from *p*=.91 to *p*=.40. The item discriminations within this sub-scale ranged from a low of .19 to a high of .36 (Table 4.3).

Table 4.3:

Knowledge Sub-Scale Items with Item Statistics *(correct response in **bold**)

Item #	***Question***	***% Selecting Distractor***	***Item Difficulty***	***Item Discrim.***
K1	Which of the following best describes technology's relationship with other fields of study? A) Technology is influenced by fields like science and engineering, but not fields like communications and transportation. B) Technology promotes advancement in science and mathematics, but science and mathematics do not promote advancement in technology. **C) Technology influences numerous fields of study and these fields also influence technology.** D) Technology is an isolated field with little impact on other areas of study. E) Technology's impact primarily includes the areas of science, mathematics, and electronics.	6.9% 1.9% -- 0.6% 2.6%	*.88*	*.23*
K2	Which of the following best describes your personal interaction with technology? A) I use my computer and cell phone, but nothing else that is technology. B) I use technologies every few days. **C) I use a wide variety of technologies, usually multiple times every day.** D) Sometimes I use technology, but only when absolutely necessary. E) I rarely use technology, it just is not really a part of my daily life.	3.2% 2.2% -- 0.7% 2.9%	*.91*	*.24*
K3	Futurists, people who look at historical data and predict what will happen in the future, say that technological change is occurring at a(n) _____rate. A) linear B) geometric C) hyperbolic D) curvilinear E) **exponential**	7.1% 2.2% 5.0% 0.7% --	*.85*	*.27*
K4	If you enrolled in a class focusing on technological literacy, which of the following most clearly identifies what you would expect to be covered? A) construction B) manufacturing and vehicles C) computers and electronics **D) communications, transportation, manufacturing, and construction** E) I have no idea what I would be learning.	1.0% 1.2% 14.4% -- 5.4%	*.78*	*.27*

Table 4.3 (continued)

Item #	***Question***	***% Selecting Distractor***	***Item Difficulty***	***Item Discrim.***
K5	All technologies can be described using the universal systems model illustrated below.  Considering the technology of a computer mouse - plastic, electronic components, and a laser would all be examples of which part of the system? A) Goal **B) Input** C) Process D) Output E) Feedback	 4.3% -- 20.2% 4.8% 3.4%	*.68*	*.19*
K6	Technology sometimes involves trade-offs. Which is an example of a trade-off? **A) Side effects of a new drug.** B) The internet allows people to share ideas more quickly and easily. C) Fossil fuels being used to provide heat and electricity. D) More people have the ability to access radio and television programing. E) The development of showerheads to conserve water during the shower.	-- 10.6% 21.2% 6.3% 7.2%	*.55*	*.36*
K7	All technologies can be described using the universal systems model illustrated below.  Neilsen Ratings for television shows and the New York Times Best Sellers list are both examples of _____. A) goal. B) input. C) process. D) output. **E) feedback.**	 2.9% 1.4% 2.9% 6.3% --	*.87*	*.36*

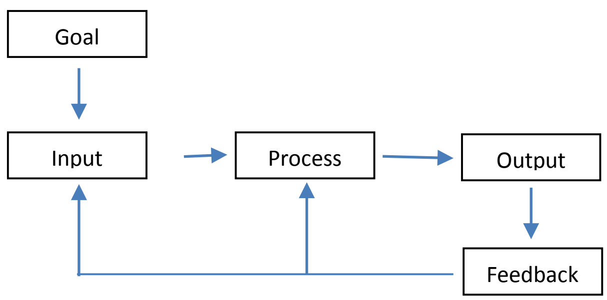
Item #	*Question*	*% Selecting Distractor*	*Item Difficulty*	*Item Discrim.*
K8	All technologies can be thought of as a system. In this context, a system is ______. **A) a group of parts that work together to achieve a goal.** B) a function properly planned and controlled. C) a final settlement. D) a scheme or method of acting or making E) the use or an instance of using this science or art.	-- 5.8% 0.9% 9.6% 3.4%	*.80*	*.34*
K9	All technologies can be described using the universal systems model illustrated below.  Which of the following is an example of output? A) Scientific knowledge about materials B) Molding plastic into a shape **C) Air pollution from cars** D) Need to determine position and speed of aircraft E) Customer comments about a product	2.4% 3.4% -- 1.4% 5.8%	*.87*	*.33*
K10	Which of the following would be considered a constraint when designing a new product? **A) Cost of materials** B) Developing possible solutions C) Communication of results D) Problem solving E) Physical solutions to a problem	-- 1.4% 0.9% 5.8% 3.9%	*.88*	*.30*
K11	Which of the following was an unanticipated risk? A) Cold medication side effect label: May cause drowsiness. B) Current building codes limiting maximum distance between deck railing. C) Safety label on a plastic bag: Keep out of reach of children. D) Pollution produced by coal fired power plants. **E) Consumer experiences automatic shut-off failure while using a space heater.**	7.7% 8.2% 6.3% 25.0% --	*.53*	*.19*

Table 4.3 (continued)

Item #	***Question***	***% Selecting Distractor***	***Item Difficulty***	***Item Discrim.***
K12	Which of the following was an anticipated risk? A) Tire blowouts caused from underinflated tires resulting in a product safety recall. **B) Pollution as a result of the mass production of automobiles.** C) The discovery of an alternative use for a drug like aspirin therapy to prevent future heart attacks. D) When the cell phone was first introduced, the number of drivers texting while driving. E) The introduction of a new species of animal which later becomes an invasive species.	16.8% -- 11.5% 10.1% 12.5%	*.49*	*.19*
K13	Adding additional USB ports to computers to meet consumer demand is an example of _____. **A) people shaping technology.** B) technology shaping human history. C) natural adaption. D) technology transfer. E) technological advancement.	-- 4.8% 6.7% 5.8% 20.7%	*.62*	*.26*
K14	Select the best answer to the following: Which of the following Ages in human history experienced technological advancement? A) Stone Age Bronze Age, and Iron Age B) Bronze Age, and Iron Age C) Middle Ages, Iron Age, and Renaissance D) Information Age and Atomic Age **E) Technology has experience advancement throughout human history**	34.1% 10.6% 6.3% 6.3% --	*.43*	*.20*
K15	In general, new technology developed and adopted in the United States will be _____. A) universally adopted by other countries and cultures. B) adopted quickly by other developed countries. **C) adopted by other countries based on values and culture.** D) not be adopted due to reputation of the United States worldwide. E) limited to use in the United States.	19.7% 24.5% -- 4.8% 3.9%	*.47*	*.32*
K16	Select the best answer for the following question: The development of life supporting technologies (example: respirators and feeding tubes) has resulted in _____. A) economic conflicts. B) values conflicts. C) societal conflicts between minority groups. D) endangerment conflict without prior consent. **E) a variety of conflicts both economic and values based.**	11.1% 8.2% 14.9% 6.7% --	*.59*	*.29*

Table 4.3 (continued)

Item #	***Question***	***% Selecting Distractor***	***Item Difficulty***	***Item Discrim.***
K17	In 1961, nearly a decade after Marion Donovan's invention of disposable diapers, the large scale manufacture of Pampers was driven by _____. A) advancement in machinery. B) invention of new materials. C) innovative spirit. D) patent expiration. **E) societal demands.**	 17.3% 13.5% 8.7% 7.7% --	*.53*	*.20*
K18	A car accident victim lost the use of his legs due to a spinal injury. He is going to travel to another country to receive an adult stem cell treatment. Which of the following best identifies this type of example? A) risk vs. benefit – Other countries have lower procedural risk. **B) value and culture of society – The country has different values and culture which makes this procedure acceptable.** C) health care system advancement – The United States does not have the technology to perform this procedure. D) government regulation – Pending Federal Drug Administration approval. E) cost – The strength of US dollar is greater in the world market.	 16.8% -- 13.5% 17.8% 12.0%	*.40*	*.21*

Capabilities-Scenario. The scenario portion of the sub-scale Capabilities was also comprised of 18 questions. This sub-scale had a mean of 10.89 (*SD*=3.34). The item difficulties for Capabilities-Scenario ranged from p=.87 to p=.17. The item discriminations ranged from .22 to .40. (Table 4.4).

Table 4.4:

Capabilities-Scenario Sub-Scale Items with Item Statistics *(correct response in **bold**)

Item #	*Question*	*% Selecting Distractor*	*Item Difficulty*	*Item Discrim.*
CS1	In most domestically produced cars, the recommended tire pressure is found on the _____. A) spare tire. B) driver's seat. C) engine block. **D) specification label.** E) sidewall of tire.	 6.3% 8.2% 7.7% -- 29.3%	*.48*	*.30*
CS2	After working on a word processing document stored on the hard drive of a computer, which menu option would you use to save the file to a USB drive instead of back on the computer? A) save **B) save as** C) options D) view E) new	 6.3% -- 3.9% 3.4% 3.4%	*.83*	*.36*
CS3	While driving down the road on the way to an appointment a steady "Service Engine Soon" amber-colored light appears on the car's instrument panel. What should happen next? A) Stop immediately alongside the road, turn the car off and call a towing company to take it to the mechanic. B) When you are stopped for a light or stop sign, turn the car off and back on to see if it stays lit. If it doesn't come back on, there is no problem. C) Drive the car normally and just ignore the light since there is no additional information. D) Stop immediately, call your destination to tell them you cannot make it and call a friend or family member for help. **E) Although it is not an emergency, you still schedule an appointment with a mechanic as soon as possible.**	 7.7% 6.3% 2.4% 1.4% --	*.82*	*.23*
CS4	Printed handouts are needed for a meeting in 30 minutes. For some unknown reason the printer will not print the document. What is the best solution to this problem? **A) Save your file and send it to another computer to see if you can print it from there.** B) Call or email your supervisor, explain the problem and ask for an extension. C) Select the command to "Print" again, it may work this time. D) Notify your supervisor that you cannot print the document; therefore, you will not be submitting it. E) Check with your supervisor to see if an electronic version is acceptable.	 -- 8.2% 5.3% 4.8% 10.6%	*.71*	*.22*

Table 4.4 (continued)

Item #	***Question***	***% Selecting Distractor***	***Item Difficulty***	***Item Discrim.***
CS5	Over time you have noticed the water flow from your bathroom faucet has been diminishing. Today while brushing your teeth the water barely dripped out of the faucet. What do you do? A) Don't worry about fixing it. You have another sink in the house, just use it. B) Call a plumber and schedule an appointment. C) Shake the handle a couple of times to see if that helps. D) Replace the faucet. **E) Remove the aerator.**	14.9% 35.6% 15.4% 16.8% --	*.17*	*.25*
CS6	You flip the light switch in your bedroom expecting the light to come on, but it does not. You check the light bulb and it does not appear to be burnt out. What do you do next? A) Keep flipping the switch, it may work again. B) Call an electrician to diagnose the problem. **C) Check the fuse or circuit breaker box for a blown fuse or tripped breaker.** D) Replace the switch. E) Change the light bulb anyway.	5.8% 8.7% -- 7.7% 11.5%	*.66*	*.34*
CS7	During the spin cycle, the washing machine begins to make a rhythmic thumping sound and is shaking. What do you do? A) Turn it off and call a repair person. B) Turn it off, open and shut the lid to see if that will fix it. C) Let it continue through the current cycle and see if it will do it with another load. **D) Open the lid and move the clothes around.** E) Restart the wash cycle again.	8.2% 14.9% 9.6% -- 7.2%	*.55*	*.35*
CS8	You have no hot water to take a shower. You know there is a gas (propane) powered hot water heater. What do you do? A) Call someone (parent, neighbor, friend, or repairperson) to come help. **B) Check the pilot light to see if it is actually still lit.** C) Call the gas company to check for an outage. D) Turn up the thermostat on the hot water heater. E) Change the heating element on the hot water heater.	16.4% -- 2.4% 6.3% 9.6%	*.65*	*.32*
CS9	Although the stapler has staples, it will not staple papers together. What do you do? A) Open the top of the stapler. Put in more staples even though there are already staples in it. **B) Pull out all of the staples to see if a staple is stuck at the end.** C) Find a different stapler. D) Squeeze the stapler harder to force it to staple. E) Move the paper and try to staple again.	3.9% -- 4.3% 1.4% 3.4%	*.87*	*.40*

Table 4.4 (continued)

<table>
<tr><th>Item #</th><th>Question</th><th>% Selecting Distractor</th><th>Item Difficulty</th><th>Item Discrim.</th></tr>
<tr><td>CS10</td><td>Your neighbor wants to reduce the utility bills of his home in the most cost effective way. The 30’ by 60’ home was built in the early 1950s. It has 15 windows and 3 doors. On average, your neighbor is spending $100 per month on his heating and cooling bill. He has identified four options to lower his utility bills:
1. add blown-insulation in the attic
2. replace windows and doors with more energy efficient ones
3. install a solar panel
4. install a wind turbine

Your neighbor has researched each option and compiled the following table of information.
<table>
<tr><th></th><th>Blown-insulation (attic only)</th><th>Replacement Doors & Windows</th><th>Solar Panel</th><th>Wind Turbine</th></tr>
<tr><td>Initial Cost</td><td>$1 per cubic foot (needs 7” in attic)</td><td>Window @ $250
Door @ $500</td><td>$27,000 complete</td><td>$22,000 complete</td></tr>
<tr><td>Tax credits</td><td>None</td><td>None</td><td>30% of cost</td><td>30% of cost</td></tr>
<tr><td>Warranty</td><td>Limited Lifetime</td><td>Limited Lifetime</td><td>Limited 10 year</td><td>Limited 15 year</td></tr>
<tr><td>Estimated Savings</td><td>$40 per year</td><td>$350 per year</td><td>100% of bill</td><td>80% of bill</td></tr>
</table>
Based on this information, which option would you suggest?
A) blown-insulation
B) replacement doors & windows
C) solar panel
D) wind turbine
E) more information is needed to make this decision</td><td>29.3%
--
8.7%
8.2%
2.4%</td><td>.51</td><td>.25</td></tr>
<tr><td>CS11</td><td>If a medical procedure has a 60% success rate, I understand _____.
A) 60 out of 100 procedures will fail.
B) it is most likely that the procedure will not work.
C) 6 out of 10 procedures will be successful.
D) the procedure is experimental since the physician doesn’t know if it will be successful or not.
E) these statistics do not apply to my situation because the procedure has not yet been done.</td><td>4.8%
2.9%
--
5.8%
4.3%</td><td>.82</td><td>.25</td></tr>
</table>

Table 4.4 (continued)

<table>
<tr><th>Item #</th><th>Question</th><th>% Selecting Distractor</th><th>Item Difficulty</th><th>Item Discrim.</th></tr>
<tr><td>CS12</td><td>To budget for a 530 mile road trip, how much money will be spent on fuel using the following information?
28 MPG
14 Gallon Fuel tank
Fuel is averaging $2.95/gallon
A) $1564
B) $265
C) $112
D) $83
E) $56</td><td>

10.1%
19.7%
15.4%
16.8%
--</td><td>.38</td><td>.32</td></tr>
<tr><td>CS13</td><td>A homeowner is preparing to remove the roof and replace it in the late spring. The current weather forecast is below. If the roofing job is estimated to take 30 work hours which would be the best choice for the homeowner?
<table>
<tr><th>Day</th><th>Forecast</th><th>High</th><th>Low</th></tr>
<tr><td>Monday</td><td>Mostly cloudy 10% chance of rain in the AM</td><td>69</td><td>41</td></tr>
<tr><td>Tuesday</td><td>Sunny</td><td>70</td><td>40</td></tr>
<tr><td>Wednesday</td><td>Partly cloudy</td><td>60</td><td>40</td></tr>
<tr><td>Thursday</td><td>Cloudy 40% chance of rain in the AM</td><td>58</td><td>34</td></tr>
<tr><td>Friday</td><td>Sunny</td><td>72</td><td>41</td></tr>
<tr><td>Saturday</td><td>Partly cloudy 20% chance of rain in the AM</td><td>70</td><td>42</td></tr>
</table>
A) Work 10 hours Monday, Tuesday and Wednesday
B) Work 15 hours Tuesday and Wednesday
C) Thursday afternoon and into Friday to make 30 hours
D) Work 10 hours each Tuesday, Wednesday, Saturday
E) Work 8 hours Tuesday, 8 hours Wednesday, 5 hours Thursday afternoon, and 9 hours Friday</td><td>--
21.6%
11.5%
12.5%
22.1%</td><td>.32</td><td>.23</td></tr>
<tr><td>CS14</td><td>Tom is buying a new refrigerator. He wants to get the best available product at the cheapest price. He has limited knowledge and experience with this type of purchase. Which source should he use to find reliable, accurate, and unbiased information?
A) retailer customer reviews
B) independent product evaluation report
C) salesperson
D) point of sale display/information
E) manufacturers websites</td><td>26.4%
--
10.6%
11.5%
13.5%</td><td>.38</td><td>.32</td></tr>
</table>

Table 4.4 (continued)

Item #	***Question***	***% Selecting Distractor***	***Item Difficulty***	***Item Discrim.***
CS15	Andre has moved to a new community in the midst of deciding whether or not to build a nuclear power facility. He wants to make an informed decision. What unbiased and current source of information would be the best choice to help him form his opinion? A) Books from the public library **B) The United States Nuclear Regulatory website** C) Brochures distributed by Green Against Nuclear Energy D) Web search E) Wikipedia	 13.9% -- 8.2% 14.4% 5.3%	*.58*	*.28*
CS16	Fracking is a process used by drilling companies to extract additional resources from the Earth. In the media there are widely diverse opinions about the safety/harm to the environment. Where would be a good place to find additional information that is reliable and unbiased? **A) Expert in the field with no connection to the industry** B) Facebook posts from friends that have similar views as you do C) Sierra Club D) Web search of the term "Fracking" E) Wikipedia	 -- 5.3% 6.3% 20.2% 7.2%	*.61*	*.34*
CS17	A loved one has been diagnosed with cancer for which there are several treatment options. Where do you find additional unbiased information to help your loved one make a decision about treatment? A) follow the doctor's advice B) talk to other family members **C) web search treatments, success rates, and side effects** D) poll your Facebook friends E) web search treatments and personal satisfaction reviews	 14.9% 8.2% -- 5.3% 11.5%	*.60*	*.33*
CS18	A cake shop is investigating adding some new flavors. To determine what flavors are most appealing to the current customer base, which of the following options would be best? **A) Set up a taste test of the new flavors in the shop and ask customers when they come in.** B) Search the internet for "experimental cake flavors" to introduce. C) Visit other cake shops and get a list of the flavors they have available. D) Poll your Facebook friends. E) Complete an internet search for "popular cake flavors".	 -- 3.7% 5.3% 4.3% 5.8%	*.81*	*.30*

Capabilities-Likert. The Likert-scale sub-scales of course resulted in higher means. Capabilities-Likert consisted of 11 items with a mean of 43.00 (*SD=6.92*). The questions means ranged from *M=4.32* (*SD=.83*) to *M=3.26* (*SD=1.40*) (Table 4.5).

Table 4.5:

Capabilities-Likert Sub-Scale Items with Item Statistics

Sub-Scale Item #	***Question***	***Descriptive Statistics***
CL1	I know how to change a flat tire on my vehicle. A) Strongly agree B) Somewhat agree C) Neutral D) Somewhat disagree E) Strongly disagree	*M=3.76* *SD=1.44*
CL2	If I have a simple problem with an appliance at home (examples: dryer will not heat or television remote will not change channels), I believe I can figure out and fix the problem. A) Strongly agree B) Somewhat agree C) Neutral D) Somewhat disagree A) Strongly disagree	*M=3.96* *SD=1.05*
CL3	While finishing a document, your computer freezes. I am confident in my ability to fix this problem. A) Strongly Agree B) Agree C) Neutral D) Disagree E) Strongly disagree	*M=3.63* *SD=1.05*
CL4	If my computer cannot connect to my wireless router, I can fix the problem. A) Strongly agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=4.02* *SD=.91*

Table 4.5 *(continued)*

Sub-Scale Item #	***Question***	***Descriptive Statistics***
CL5	I could light the pilot on a gas hot water heater. A) Strongly agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=3.26* *SD=1.40*
CL6	If I returned to my car and it would not start, I know how to jumpstart my car. A) Strongly agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=4.20* *SD=1.10*
CL7	If a medical procedure has an 80% success rate, I understand how that relates to risk. A) Strongly Agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=4.32* *SD=.83*
CL8	I can estimate how many tanks of fuel my car will need for a 670 mile road trip to determine if I can afford to make the trip. A) Strongly Agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=4.09* *SD=.92*
CL9	When I move into a new residence, I can determine if my belongings will fit. A) Strongly Agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=4.29* *SD=.76*
CL10	Last year's grass seed has a predicted germination rate of 75%. This year's grass seed is more expensive, but has a predicted germination rate of 95%. If I know the cost of each seed per pound, I can calculate which would be most cost effective. A) Strongly Agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=3.73* *SD=1.00*

Table 4.5 *(continued)*

Sub-Scale Item #	***Question***	***Descriptive Statistics***
CL11	I can research an area of technology without using the internet. A) Strongly agree B) Agree C) Neither agree nor disagree D) Disagree E) Strongly disagree	*M=3.74* *SD=1.10*

Critical Thinking. The last sub-scale, Critical Thinking, only included 7 questions with a mean of 29.04 (*SD*=3.65). The item means within this sub-scale ranged from *M=4.40* (*SD=.78*) to *M=3.83* (*SD=1.25*) (Table 4.6).

Table 4.6:

Critical Thinking Sub-Scale Items with Item Statistics

Sub-Scale Item #	***Question***	***Descriptive Statistics***
CT1	Before making the decision purchase a new cell phone and plan, I would identify information about features, benefits, and risks. A) Strongly agree B) Somewhat agree C) Neutral D) Somewhat disagree E) Strongly disagree	*M=4.40* *SD=.78*
CT2	When I need to make an important decision I gather information from a variety of sources. A) Strongly agree B) Somewhat agree C) Neutral D) Somewhat disagree E) Strongly disagree	*M=4.30* *SD=.80*

Table 4.6 *(continued)*

Sub-Scale Item #	***Question***	***Descriptive Statistics***
CT3	I try to think of many different questions when I consider benefits and risks of technologies. A) Strongly agree B) Somewhat agree C) Neutral D) Somewhat disagree E) Strongly disagree	*M=4.01* *SD=.90*
CT4	I consider pros and cons when I need to make a decision to purchase a technological device. A) Always B) Often C) Sometimes D) Rarely E) Never	*M=3.83* *SD=1.25*
CT5	Making decisions about technology involves evaluating trade-offs. A) Always B) Often C) Sometimes D) Rarely E) Never	*M=4.07* *SD=.94*
CT6	I compare benefits and risks when I need to make a decision about using a technology. A) Always B) Often C) Sometimes D) Rarely E) Never	*M=3.96* *SD=1.02*
CT7	Cost is a factor I consider when making decisions about technology. A) Always B) Often C) Sometimes D) Rarely E) Never	*M=4.46* *SD=.88*

The instrument, in its entirety, has a total of 54 items with at total possible score of 126. The entire measure had a mean of 95.04 (*SD=12.31*) and α=.84.

Validity

Several analyses were conducted to investigate the validity of the Adult Technological Literacy Scale. First, correlations among the sub-scales were computed. Second, each subscale was correlated with two existing instruments (and their respective sub-scales) which are believed to measure an aspect of technological literacy. Finally, performance on a course final was correlated with scores on the Adult Technological Literacy Scale.

The correlation coefficients were calculated for the four sub-scales. All six of the correlations were significant ($p \leq .001$) and greater or equal to .27. When the sub-scale correlations were corrected for attenuation, the values ranged from a low of .36 (Knowledge & Capabilities-Likert) to a high of .61 (Knowledge and Capabilities-Scenario). These results suggest that the sub-scales developed to measure technological literacy are positively related to one another, yet measure slightly different aspects of the construct (Table 4.7).

Table 4.7:

Observed (Pearson) Correlation and Theoretical (Correction for Attenuation) Correlation among the Four Sub-Scales of the Adult Technological Literacy Scale (N=208)

Observed	**K**	**CS**	**CL**	**Theoretical**	**K**	**CS**	**CL**
Capabilities-Scenario	**.43****			**Capabilities-Scenario**	.61		
Capabilities-Likert	**.27****	**.34****		**Capabilities-Likert**	.36	.45	
Critical Thinking	**.37****	**.35****	**.34****	**Critical Thinking**	.57	.52	.48

$^{**}p \leq .001$

The measure developed at Old Dominion University, Survey of Technological Literacy, was identified by the developer to have two sub-scales (Impacts of Technology and Technology Working Knowledge). These two sub-scales indicated a significant positive correlation ($p \leq .01$)

with each of the newly developed sub-scales: Knowledge, Capabilities-Scenario, Capabilities-Likert, and Critical Thinking (Table 4.8). The highest correlation of *r(206)=.59, p≤.001* occurred between the Capabilities-Likert sub-scale on the new measure and the Technology Knowledge sub-scale on the Survey of Technological Literacy. The lowest correlation of *r(206)=.21, p=.004* was still significant and modestly positive between Knowledge and Impacts of Technology. The sub-scales for the new measure were transformed to z-score and the weighted average total z-score was calculated. This score had a strong, positive, significant correlation with the Survey of Technological Literacy total score (*r(206)=.60, p≤.001*). The correction of attenuation results in higher correlations ranging from .38 (Knowledge & STL: Impacts of Technology) to .75 (STL: Impacts of Technology with both Capabilities-Likert and Critical Thinking). These correlations indicated the instrument produced to measure technological literacy at Old Dominion University is related to the new measure developed.

Table 4.8:

Observed (Pearson) Correlation and Theoretical (Correction for Attenuation) Correlation between Four Sub-Scales of the Adult Technological Literacy Scale and the Survey of Technological Literacy (N=208)

Observed	**STL: Impacts of Tech**	**STL: Tech Know**	**STL: Total Score**	**Theoretical**	**STL: Impacts of Tech**	**STL: Tech Know**	**STL: Total Score**
Knowledge	**.21****	**.31*****	**.31*****	**Knowledge**	.38	.43	.42
Capabilities-Scenario	**.30*****	**.43*****	**.43*****	**Capabilities-Scenario**	.52	.57	.56
Capabilities-Likert	**.46*****	**.59*****	**.60*****	**Capabilities-Likert**	.75	.74	.74
Critical Thinking	**.40*****	**.36*****	**.40*****	**Critical Thinking**	.75	.51	.56
Weighted Average Total z-Score			**.60*****	**Weighted Average Total z-Score**			.74

$^{***}p \le .001$, $^{**}p \le .01$

The Technology Profile Inventory (TPI) developed at the University of Cape Town was identified to have five sub-scales: Artifact, Engagement, Directions, Processes, and Tinkering. A significant, but weak positive correlations exist between Critical Thinking and TPI: Processes ($r(206)=.16$, $p=.03$). TPI: Directions indicated a significant positive relationship with all of the sub-scales from the new measure (Knowledge: $r(206)= .28$, $p\leq.001$), Capabilities-Scenario: $r(206)=.35$, $p\leq.001$, Capabilities-Likert: $r(206)=.28$, $p\leq.001$, and Critical Thinking: $r(206)=.25$, $p\leq.001$). The total score from the TPI was also significantly correlated with all four sub-scales. The strongest of which was the modest relationship with Critical Thinking at $r(206)=.27$, $p\leq.001$. The weakest and non-significant relationships were between TPI: Artifact and all four sub-scales, as well as, TPI: Engagement and all four sub-scales. The weighted average total z-score was also positively related to with the TPI: Total Score ($r(206)=.32$, $p\leq.001$). The theoretical correlations between sub-scales ranged from .24 (the Although weaker relationships than those that existed with the Old Dominion instrument, the TPI instrument is measuring some of the same components of the technological literacy construct (Table 4.9).

Table 4.9:

Observed (Pearson) Correlation and Theoretical (Correction for Attenuation) Correlation among the Four Sub-Scales of the Adult Technological Literacy Scale and Technology Profile Inventory (TPI) (N=208)

Observed	**Knowledge**	**Capabilities Scenario**	**Capabilities Likert**	**Critical Thinking**	**Weighted Avg Total z-Score**
TPI: Artifact	.08	.03	-.07	.06	
TPI: Processes	-.03	.01	.11	**.16***	
TPI: Engagement	.09	.06	.14	.12	
TPI: Directions	**.28*****	**.35*****	**.28*****	**.25*****	
TPI: Tinkering	-.01	.07	.11	.01	
TPI: Total Score	**.17***	**.23****	**.25*****	**.27*****	**.32*****
Theoretical					
TPI: Artifact	.11	.04	-.09	.09	
TPI: Processes	-.04	.01	.14	.23	
TPI: Engagement	.18	.12	.26	.26	
TPI: Directions	.37	.45	.34	.35	
TPI: Tinkering	-.02	.13	.19	.02	
TPI: Total Score	.24	.32	.32	.40	.42

$^{***}p \leq .001$, $^{**}p \leq .01$, $^{*}p \leq .05$

Also significant were the positive correlations between all four sub-scales and the GT190 Fall 2013 Final Exam which was used as a pre-test in the course (Table 4.9). The strongest correlation exists between Fall 2013 Final Exam/Knowledge *(r(206)=.39, p≤.000)* and Fall 2013 Final Exam/Capabilities-Scenario *(r(206)=.38, p≤..000).*The weighted average total z-score also exhibited a moderate, positive correlation with the Fall 2013 Final Exam. The theoretical correlation after correction for attenuation ranges from .29 (Capabilities-Likert and Final Exam) to .47 (Knowledge and Final Exam) (Table 4.10).

Table 4.10:

Observed (Pearson) Correlation and Theoretical (Correction for Attenuation) Correlation between Four Sub-Scales of the Adult Technological Literacy Scale and the Final Exam (N=208)

	Fall 2013 Final Exam (Observed)	**Fall 2013 Final Exam (Theoretical)**
Knowledge	**.39****	.47
Capabilities-Scenario	**.38****	.44
Capabilities-Likert	**.26****	.29
Critical Thinking	**.29****	.37
Weighted Average Total z-Score	**.46*****	.52

***$p \leq .001$, **$p \leq .01$

Chapter 5: Discussion

This study's primary purpose was to develop a valid and reliable measure of technological literacy for post-secondary adults. Specifically, this study identified the construct of interest, developed questions to measure the construct, utilized experts and a focus group to review the questions, analyzed evidence produced as a result of the administration of the measure, and compared the evidence with existing measures available.

A new measure of technological literacy must be valid. The development of a Table of Specifications which was aligned with the National Standards (ITEA, 2000) as well as the commonly published characteristics of the technologically literate person (ITEA, 1996; ITEA, 2005, Moye et al., 2012, and Ritz 2011) and technological literacy models (National Academy of Engineering & National Research Council, 2002 & 2006) provided a guide, which in turn, aids in instrument validity. The table of specifications ensured an appropriate distribution of questions which, in turn, allowed for a balanced measurement of technological literacy.

In addition to meeting the theoretical construct of technological literacy, experts in the field also contributed to the measure's validity. The professionals within the field of technological literacy who are considered to be experts offer insight related to if and how potential questions measure the construct of interest (technological literacy). Review of the questions by these experts also provides evidence for validity.

Even if the experts believe the questions accurately measured the intended benchmark and operationalization, the questions could still have been unclear or confusing to those actually completing the instrument. For this reason, the perceptions from the focus group identified from part of the intended population, allows for additional improvement of the instrument. This group offered a different perspective of the overall measure. These students did not have the same close relationship to the construct as the experts and this researcher. The students who participated in the focus group suggested modifications and preferences between similar questions. The focus group allowed for further enhancement of the measure and added to the final measure's validity.

Correlation coefficients calculations provided additional evidence of validity. The significant and positive associations between the four sub-scales indicate they are related to one another, but are measuring different aspects of technological literacy. The highest correlation exists between Knowledge and Capabilities-Scenario which could be illustrating the direct relationship a subject's knowledge has on his or her capabilities within a particular situation. These two scales also use the same question format which may also support the association. Critical thinking is difficult to measure in a set question format, yet in this measure its link across the other three sub-scales would be considered moderate. When the correlation coefficient was corrected for attenuation, the theoretical correlations increased which further indicates the relationship between the sub-scales. The way these sub-scales affiliate with each other provides additional evidence of the measure's validity.

Comparing existing measures with a newly developed instrument can indicate the measures are assessing the same construct of interest which adds to validity of the new instrument. The measure produced by Old Dominion University targeted the same population of interest (post-secondary adults taking an introductory technological literacy course in college) and identified the same purpose of the instrument (measure technological literacy) as this study. The connections between the Old Dominion measure and the instrument developed for this study indicate both are measuring the same construct, yet done so with slightly different scales. The Old Dominion measure developed questions based on course objectives which were derived from the university's general educations goals, the Standards for Technological Literacy, and professionally accepted characteristics of a technologically literate person. In contrast, the new measure focused only on the Standards for Technological Literacy and Characteristics of a Technologically Literacy person. The Old Dominion measure also divided technological literacy into different sub-scales which may account for each subscale having a moderate correlation with the new measure, yet the overall score of both have a stronger relationship. The theoretical correlation between the existing measure's sub-scales and the sub-scales on the new measure fosters the relationship between the two instruments. The statistical link between these two measures provides supplementary evidence for the validity of the newly developed instrument.

Although most of the Technology Profile Inventory (TPI) developed by the University of Cape Town did not significantly correlate with the new measure, the total score did. This could be attributed to how the individual sub-scales were developed. The TPI was developed using the phenomenographic research approach to identify the specific questions which would later be utilized in the measure. Although the original information used to guide this process was the same set of Standards for Technological Literacy developed by the International Technology and Engineering Education Association used for this study, the process itself allowed the questions in the final measure to evolve, which in turn directed the sub-scales. This measure has also not previously been used outside of South Africa, which could also contribute to differences in the sample of the population. Even so, statistically both measure are similar and therefore contributes to the new instrument validity.

The relationship between the Fall 2013 Final Exam and the newly developed instrument offers more evidence of validity. The course which utilizes the final/pretest was designed by faculty at Pittsburg State University to address the university's general education goals and to meet the widely accepted characteristics of technologically literate persons. Although not exactly the same purpose, nor developed with the same guidelines as the newly develop measure, the final/pretest does address important areas of technological literacy. The significant and positive associations between the two measures both observed and theoretically calculated again, adds to the validity of the new measure.

Limitations

The key limitation to this study was the sample. While this sample group was of adequate size for the development and testing of the measure, it is limited in generalizability to the adult population. Pittsburg State University is a typical mid-sized Midwest university, but the primary student population is not very diverse. Also, 41 students elected not to participate in the study. They could represent an aspect of the population which should be included in the development of this instrument.

Another limitation is related to the definition of the construct of technological literacy. Although a genuine attempt has been made to define technological literacy as the term is defined by professionals in the field, it is not a definition embraced by all researcher or the lay population. A prime example has been illustrated in the data analysis comparing the instruments from Old Dominion University and University of Cape Town. The producers of the Survey for Technological Literacy designed the measure for a similar purpose as the Adult Technological Literacy Scale, which is indicative of the higher correlations between the two measures. In contrast, the makers of the Technology Inventory Profile approached development by focusing on terminology used by students and let this information frame the questions which were included on the final instrument. As a consequence, there are areas of the measure which do not correlate with the Adult Technological Literacy Scale. The new scale (Adult Technological

Literacy Scale) did not identify an area related to “Tinkering” and no significant correlations existed.

Finally, there exists the inherent limitation related to the effectiveness of measuring some constructs in this format. Being able to actually quantify an individual’s capabilities related to technology is more difficult using this delivery format than specific knowledge about technology. Someone may have the capability to complete a task related to technology, yet may approach it differently than the option responses allow. Also, the ability to self-report capabilities may not be the most accurate way to quantify the construct. There exists those who don’t know what they know; therefore, although unintentional may not correctly report their capabilities or ability to think critically. At the same time, an individual may actually have the ability to think critically, but the way the question is written and the options provided, the measure might not accurately capture this information.

Implications

The importance of measuring technological literacy has become more evident as the subject area has increased its presence in society and at educational institutions. The resulting instrument developed here offers educators and researchers the ability to capture important dimensions of technological literacy in the determination of post-secondary adult technological literacy.

This study indicates the instrument: Adult Technological Literacy Scale is a valid and reliable instrument for measuring technological literacy. This measure is a multiple-choice/Likert-scale instrument that can be readily administered and scored in large-enrollment general education courses. The instrument includes items designed to measure knowledge, capabilities, and critical thinking as they all relate to technological literacy. This particular instrument focuses on the national Standards of Technological Literacy and characteristics of a technologically literate person and is not swayed by individual beliefs or agendas of the instructor or institution.

This instrument could be used as a standard measure across instructors, courses, and institutions. This type of comparison would allow for improved teaching of technological literacy, which in turn should contribute to the advancement of technological literacy education research.

The majority of the literature about technological literacy focuses on its multidimensionality. For this reason, it is important that the sub-scales within the measure are not actually independent component, instead that are part of the whole concept called technological literacy. These sub-scales can indicate where the holes may exist, but when referring to the overall concept of technological literacy, each is as important as the other. This idea is further supported in the statistical relationships between the sub-scales.

Recommendations

The process completed has developed a valid and reliable instrument. This being said, the instrument would still benefit from going through a larger pilot test with a more representative sample of the entire population (post-secondary adults), which could lead to additional improvement. The measure in its current state is appropriate for use by researcher interested in measuring the current level of technological literacy.

Further research should be conducted to identify the measure's sensitivity. Being able to use the measure to detect pre- to post-semester literacy gains would allow instructors to evaluate the need to change or develop classroom activities to support necessary skill development in technological literacy. The importance of technological literacy as a component of the push for reform in university STEM education, particularly in general education curriculum indicates the pressing need for Adult Technological Literacy Scale.

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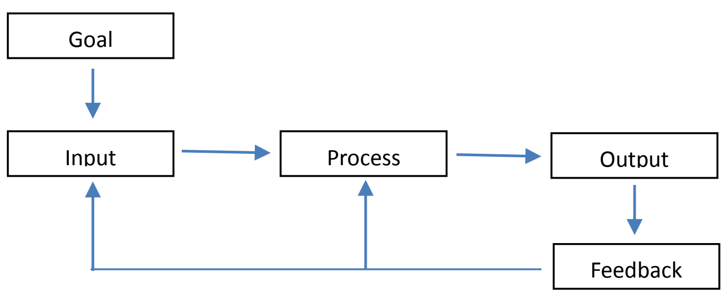
Appendix A: Adult Technological Literacy Scale

Instructions: These questions are designed to assess your knowledge about technology. There are 18 questions. Please read each question carefully and select the best answer.

1. Which of the following best describes technology's relationship with other fields of study?
   A) Technology is influenced by fields like science and engineering, but not fields like communications and transportation.
   B) Technology promotes advancement in science and mathematics, but science and mathematics do not promote advancement in technology.
   C) Technology influences numerous fields of study and these fields also influence technology.
   D) Technology is an isolated field with little impact on other areas of study.
   E) Technology's impact primarily includes the areas of science, mathematics, and electronics.

2. Which of the following best describes your personal interaction with technology?
   A) I use my computer and cell phone, but nothing else that is technology.
   B) I use technologies every few days.
   C) I use a wide variety of technologies, usually multiple times every day.
   D) Sometimes I use technology, but only when absolutely necessary.
   E) I rarely use technology, it just is not really a part of my daily life.

3. All technologies can be described using the universal systems model illustrated below.



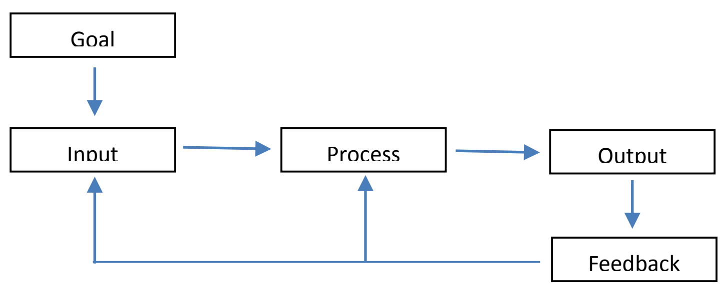
   Considering the technology of a computer mouse - plastic, electronic components, and a laser would all be examples of which part of the system?
   A) Goal
   B) Input
   C) Process
   D) Output
   E) Feedback

4. Futurists, people who look at historical data and predict what will happen in the future, say that technological change is occurring at a(n) _____rate.
   A) linear
   B) geometric
   C) hyperbolic
   D) exponential
   E) curvilinear

5. If you enrolled in a class focusing on technological literacy, which of the following most clearly identifies what you would expect to be covered?
   A) construction
   B) manufacturing and vehicles
   C) computers and electronics
   D) communications, transportation, manufacturing, and construction
   E) I have no idea what I would be learning.

6. All technologies can be thought of as a system. In this context, a system is _____.
   A) a group of parts that work together to achieve a goal.
   B) a function properly planned and controlled.
   C) a final settlement.
   D) a scheme or method of acting or making.
   E) the use or an instance of using this science or art.

7. All technologies can be described using the universal systems model illustrated below.



   Neilsen Ratings for television shows and the New York Times Best Sellers list are both examples of _____.
   A) goal.
   B) input.
   C) process.
   D) output.
   E) feedback.

8. Technology sometimes involves trade-offs. Which is an example of a trade-off?
   A) Side effects of a new drug.
   B) The internet allows people to share ideas more quickly and easily.
   C) Fossil fuels being used to provide heat and electricity.
   D) More people have the ability to access radio and television programing.
   E) The development of showerheads to conserve water during the shower.

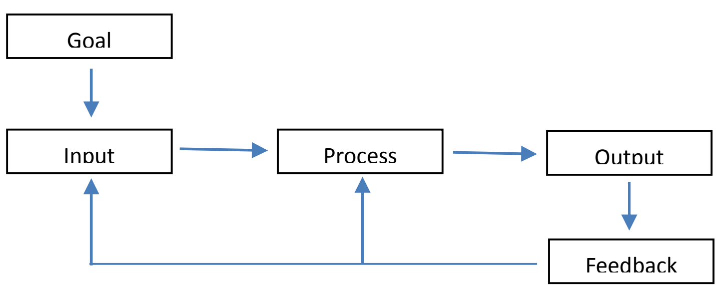
9. Which of the following would be considered a constraint when designing a new product?
   A) cost of materials
   B) developing possible solutions
   C) communication of results
   D) problem solving
   E) physical solutions to a problem

10. Select the best answer to the following:

    Which of the following Ages in human history experienced technological advancement?

    A) Bronze Age, and Iron Age
    B) Information Age and Atomic Age
    C) Stone Age Bronze Age, and Iron Age
    D) Middle Ages, Iron Age, and Renaissance
    E) Technology has experience advancement throughout human history

11. All technologies can be described using the universal systems model illustrated below.



    Which of the following is an example of output?
    A) scientific knowledge about materials
    B) molding plastic into a shape
    C) air pollution from cars
    D) need to determine position and speed of aircraft
    E) customer comments about a product

12. Which of the following was an unanticipated risk?
    A) Cold medication side effect label: May cause drowsiness.
    B) Pollution produced by coal fired power plants.
    C) Safety label on a plastic bag: Keep out of reach of children.
    D) Consumer experiences automatic shut-off failure while using a space heater.
    E) Current building codes limiting maximum distance between deck railing.

13. Which of the following was an anticipated risk?
    A) Tire blowouts caused from underinflated tires resulting in a product safety recall.
    B) Pollution as a result of the mass production of automobiles.
    C) The discovery of an alternative use for a drug like aspirin therapy to prevent future heart attacks.
    D) When the cell phone was first introduced, the number of drivers texting while driving.
    E) The introduction of a new species of animal which later becomes an invasive species.

14. Adding additional USB ports to computers to meet consumer demand is an example of ___.
    A) people shaping technology.
    B) technology shaping human history.
    C) natural adaption.
    D) technology transfer.
    E) technological advancement.

15. In general, new technology developed and adopted in the United States will be ___.
    A) universally adopted by other countries and cultures.
    B) adopted quickly by other developed countries.
    C) adopted by other countries based on values and culture.
    D) not adopted due to reputation of the United States worldwide.
    E) limited to use in the United States.

16. Select the best answer for the following question:

    The development of life supporting technologies (example: respirators and feeding tubes) has resulted in ___.
    A) economic conflicts.
    B) values conflicts.
    C) societal conflicts between minority groups.
    D) endangerment conflict without prior consent.
    E) a variety of conflicts both economic and values based.

17. In 1961, nearly a decade after Marion Donovan's invention of disposable diapers, the large scale manufacture of Pampers® was driven by ___.
    A) advancement in machinery.
    B) invention of new materials.
    C) societal demands.
    D) innovative spirit.
    E) patent expiration.

18. A car accident victim lost the use of his legs due to a spinal injury. He is going to travel to another country to receive an adult stem cell treatment. Which of the following best identifies this type of example?
    A) risk vs. benefit – Other countries have lower procedural risk.
    B) value and culture of society – The country has different values and culture which makes this procedure acceptable.
    C) health care system advancement – The United States does not have the technology to perform this procedure.
    D) government regulation – Pending Federal Drug Administration approval.
    E) cost – The strength of US dollar is greater in the world market.

<u>Instructions:</u> These questions are designed to assess your capabilities with technology. There are 18 questions. Please read each question carefully and select the best answer.

1. After working on a word processing document stored on the hard drive of a computer, which menu option would you use to save the file to a USB drive instead of back on the computer?
    - A) save
    - **B) save as**
    - C) options
    - D) view
    - E) new

2. While driving down the road on the way to an appointment a steady "Service Engine Soon" amber-colored light appears on the car's instrument panel. What should happen next?
    - A) Stop immediately alongside the road, turn the car off and call a towing company to take it to the mechanic.
    - B) When you are stopped for a light or stop sign, turn the car off and back on to see if it stays lit. If it doesn't come back on, there is no problem.
    - C) Drive the car normally and just ignore the light since there is no additional information.
    - D) Stop immediately, call your destination to tell them you cannot make it and call a friend or family member for help.
    - **E) Although it is not an emergency, you still schedule an appointment with a mechanic as soon as possible.**

3. In most domestically produced cars, the recommended tire pressure is found on the _____.
    - A) spare tire.
    - B) driver's seat.
    - C) engine block.
    - **D) specification label.**
    - E) sidewall of tire.

4. Printed handouts are needed for a meeting in 30 minutes. For some unknown reason the printer will not print the document. What is the best solution to this problem?
    - **A) Save your file and send it to another computer to see if you can print it from there.**
    - B) Call or email your supervisor, explain the problem and ask for an extension.
    - C) Select the command to "Print" again, it may work this time.
    - D) Notify your supervisor that you cannot print the document; therefore, you will not be submitting it.
    - E) Check with your supervisor to see if an electronic version is acceptable.

5. Over time you have noticed the water flow from your bathroom faucet has been diminishing. Today while brushing your teeth the water barely dripped out of the faucet. What do you do?
   A) Don't worry about fixing it. You have another sink in the house, just use it.
   B) Call a plumber and schedule an appointment.
   C) Shake the handle a couple of times to see if that helps.
   D) Replace the faucet.
   E) Remove the aerator.

6. You flip the light switch in your bedroom expecting the light to come on, but it does not. You check the light bulb and it does not appear to be burnt out. What do you do next?
   A) Keep flipping the switch, it may work again.
   B) Call an electrician to diagnose the problem.
   C) Check the fuse or circuit breaker box for a blown fuse or tripped breaker.
   D) Replace the switch.
   E) Change the light bulb anyway.

7. During the spin cycle, the washing machine begins to make a rhythmic thumping sound and is shaking. What do you do?
   A) Turn it off and call a repair person.
   B) Turn it off, open and shut the lid to see if that will fix it.
   C) Let it continue through the current cycle and see if it will do it with another load.
   D) Open the lid and move the clothes around.
   E) Restart the wash cycle again.

8. You have no hot water to take a shower. You know there is a gas (propane) powered hot water heater. What do you do?
   A) Call someone (parent, neighbor, friend, or repairperson) to come help.
   B) Check the pilot light to see if it is actually still lit.
   C) Call the gas company to check for an outage.
   D) Turn up the thermostat on the hot water heater.
   E) Change the heating element on the hot water heater.

9. Although the stapler has staples, it will not staple papers together. What do you do?
   A) Open the top of the stapler. Put in more staples even though there are already staples in it.
   B) Find a different stapler.
   C) Squeeze the stapler harder to force it to staple.
   D) Move the paper and try to staple again.
   E) Pull out all of the staples to see if a staple is stuck at the end.

10. Your neighbor wants to reduce the utility bills of his home in the most cost effective way. The 30' by 60' home was built in the early 1950s. It has 15 windows and 3 doors. On average, your neighbor is spending $100 per month on his heating and cooling bill. He has identified four options to lower his utility bills:
    1. add blown-insulation in the attic
    2. replace windows and doors with more energy efficient ones
    3. install a solar panel
    4. install a wind turbine

    Your neighbor has researched each option and compiled the following table of information.

	Blown-insulation (attic only)	Replacement Doors & Windows	Solar Panel	Wind Turbine
Initial Cost	$1 per cubic foot (needs 7" in attic)	Window @ $250 Door @ $500	$27,000 complete	$22,000 complete
Tax credits	None	None	30% of cost	30% of cost
Warranty	Limited Lifetime	Limited Lifetime	Limited 10 year	Limited 15 year
Estimated Savings	$40 per year	$350 per year	100% of bill	80% of bill

    Based on this information, which option would you suggest?
    A) blown-insulation
    B) replacement doors & windows
    C) solar panel
    D) wind turbine
    E) more information is needed to make this decision

11. If a medical procedure has a 60% success rate, I understand _____.
    A) 60 out of 100 procedures will fail.
    B) it is most likely that the procedure will not work.
    C) 6 out of 10 procedures will be successful.
    D) the procedure is experimental since the physician doesn't know if it will be successful or not.
    E) these statistics do not apply to my situation because the procedure has not yet been done.

12. Tom is buying a new refrigerator. He wants to get the best available product at the cheapest price. He has limited knowledge and experience with this type of purchase. Which source should he use to find reliable, accurate, and unbiased information?
    A) retailer customer reviews
    B) salesperson
    C) point of sale display/information
    D) independent product evaluation report
    E) manufacturers websites

13. A homeowner is preparing to remove the roof and replace it in the late spring. The current weather forecast is below. If the roofing job is estimated to take 30 work hours which would be the best choice for the homeowner?

Day	Forecast	High	Low
Monday	Mostly cloudy 10% chance of rain in the AM	69	41
Tuesday	Sunny	70	40
Wednesday	Partly cloudy	60	40
Thursday	Cloudy 40% chance of rain in the AM	58	34
Friday	Sunny	72	41
Saturday	Partly cloudy 20% chance of rain in the AM	70	42

    A) Work 10 hours Monday, Tuesday and Wednesday
    B) Work 15 hours Tuesday and Wednesday
    C) Thursday afternoon and into Friday to make 30 hours
    D) Work 10 hours each Tuesday, Wednesday, Saturday
    E) Work 8 hours Tuesday, 8 hours Wednesday, 5 hours Thursday afternoon, and 9 hours Friday

14. Andre has moved to a new community in the midst of deciding whether or not to build a nuclear power facility. He wants to make an informed decision. What unbiased and current source of information would be the best choice to help him form his opinion?
    A) books from the public library
    B) brochures distributed by Green Against Nuclear Energy
    C) the United States Nuclear Regulatory website
    D) web search
    E) Wikipedia

15. To budget for a 530 mile road trip, how much money will be spent on fuel using the following information?

    28 MPG
    14 Gallon Fuel tank
    Fuel is averaging $2.95/gallon

    A) $1564
    B) $265
    C) $112
    D) $83
    E) $56

16. Fracking is a process used by drilling companies to extract additional resources from the Earth. In the media there are widely diverse opinions about the safety/harm to the environment. Where would be a good place to find additional information that is reliable and unbiased?

    A) Expert in the field with no connection to the industry
    B) Facebook posts from friends that have similar views as you do
    C) Sierra Club
    D) web search of the term "Fracking"
    E) Wikipedia

17. A loved one has been diagnosed with cancer for which there are several treatment options. Where do you find additional unbiased information to help your loved one make a decision about treatment?

    A) follow the doctor's advice
    B) talk to other family members
    C) web search treatments, success rates, and side effects
    D) poll your Facebook friends
    E) web search treatments and personal satisfaction reviews

18. A cake shop is investigating adding some new flavors. To determine what flavors are most appealing to the current customer base, which of the following options would be best?

    A) Set up a taste test of the new flavors in the shop and ask customers when they come in.
    B) Search the internet for "experimental cake flavors" to introduce.
    C) Visit other cake shops and get a list of the flavors they have available.
    D) Poll your Facebook friends.
    E) Complete an internet search for "popular cake flavors".

Instructions: These questions explore your relationship with technology. There are a total 11 questions in this section. Please read each question carefully and indicate how much you agree with the statement by circling a number.

SA	A	N	D	DS
5	(4)	3	2	1

5 = strongly agree   4 = agree   3 = neutral   2 = disagree   1 = strongly disagree.

		SA	A	N	D	DS
CL1	If I have a simple problem with an appliance at home (examples: dryer will not heat or television remote will not change channels), I believe I can figure out and fix the problem.	5	4	3	2	1
CL2	I know how to change a flat tire on my vehicle.	5	4	3	2	1
CL3	If I returned to my car and it would not start, I know how to jumpstart my car.	5	4	3	2	1
CL4	I can estimate how many tanks of fuel my car will need for a 670 mile road trip to determine if I can afford to make the trip.	5	4	3	2	1
CL5	I could light the pilot on a gas hot water heater.	5	4	3	2	1

5 = strongly agree   4 = agree   3 = neutral   2 = disagree   1 = strongly disagree.

		SA	A	N	D	DS
CL6	While finishing a document, the computer freezes. I am confident in my ability to fix this problem.	5	4	3	2	1
CL7	If my computer cannot connect to my wireless router, I can fix the problem.	5	4	3	2	1
CL8	If a medical procedure has an 80% success rate, I understand how that relates to risk.	5	4	3	2	1
CL9	When I move into a new residence, I can determine if my belongings will fit prior to moving them.	5	4	3	2	1
CL10	Last year's grass seed has a predicted germination rate of 75%. This year's grass seed is more expensive, but has a predicted germination rate of 95%. If I know the cost of each seed per pound, I can calculate which would be the most cost effective.	5	4	3	2	1
CL11	I can research an area of technology without using the internet.	5	4	3	2	1

Critical Thinking

Instructions: These questions explore your decision making related to technology. Please read each question carefully and indicate how much you agree with the statement by circling a number.

SA	A	N	D	DS
5	4	(3)	2	1

5 = strongly agree   4 = agree   3 = neutral   2 = disagree   1 = strongly disagree.

		SA	A	N	D	DS
CT1	Before making the decision to purchase a new cell phone and plan, I would identify information about features, benefits, and risks.	5	4	3	2	1
CT2	When I need to make an important decision I gather information from a variety of sources.	5	4	3	2	1
CT3	I try to think of many different questions when I consider benefits and risks of technologies.	5	4	3	2	1

Instructions: These questions explore your decision making related to technology. Please read each question carefully and indicate the frequency you complete the statement by circling a number.

A	O	S	R	N
5	4	(3)	2	1

5 = Always   4 = Often   3 = Sometimes   2 = Rarely   1 = Never

		A	O	S	R	N
CT4	I consider pros and cons when I need to make a decision to purchase a technological device.	5	4	3	2	1
CT5	Making decisions about technology involves evaluating trade-offs.	5	4	3	2	1
CT6	I compare benefits and risks when I need to make a decision about using a technology.	5	4	3	2	1
CT7	Cost is a factor I consider when making decisions about technology.	5	4	3	2	1

Appendix B: Other Measures

Survey of Technological Literacy

Each of the following statements have the following possible responses:

Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree

Impacts of Technology

1. I am aware of and understand how technology has evolved from the Stone Age to the present
2. I understand the impact technology has on the development of society
3. I feel comfortable in using the problem solving methods to solve a problem
4. I understand that different career fields are based on upon the application of technology
5. I have taken technology courses prior to this course

Technology Working Knowledge

1. I understand the difference between energy sources
2. I understand that many products may be made from polymer and composite materials.
3. I have used materials to construct/build something of my own
4. I know that technology evolves over time
5. I understand that all technologies have social, cultural, environmental, economic, and political impacts.
6. I can identify the basic components of an electrical circuit.
7. I enjoy working with my hands.
8. I use the Internet as a resource tool to locate information on topics of interest to me.
9. I use the Internet on a daily basis.
10. I communicate mainly by email/text messaging
11. I see that computers can be applies to various technologies.
12. I understand the purpose of construction building codes.
13. I know that different types of construction require different technologies
14. I understand how products are manufactured
15. I understand that transportation is a vital component of advanced societies.
16. I know what is meant by biotechnologies
17. I know what is meant by nanotechnology

Technology Profile Inventory

Each of the following statements have the following possible responses:

Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree

Nature of Technology – Artifact

1. A washing machine thrown on a rubbish dump with no motor or wires is no longer technology. It is just a thing.
2. An amplifier or CD player becomes technology when it is switched on.
3. Technology is all about computers and other electronic and electrical things like that.
4. A CD is only technology when you put the CD into a computer and then copy music onto it.
5. A television is technology only when you watch a movie on it using signal from the air.

Nature of Technology – Process

1. Technology is a person making something to solve a problem and improve quality of life.
2. Technology is an idea that has been put into place by someone to help people.
3. Technology is about using scientific knowledge to make something.
4. Technology is making use of knowledge people have about something and using this to solve a problem.
5. Technology is using knowledge and skill to develop some product.
6. Something is technology because a person had a plan that was put into practice by making it.
7. Technology is about solving a problem.
8. Technology is the planning and research of something and then the making of it.

Interacting with Technological Artifact – Directions/Instructions

1. I would rather get someone else to work a technological thing. I might get it wrong or mess it up.
2. Only with instructions, I would be able to find how to do what I want with a technological thing.
3. Only if someone first shows me how to do something with a technological thing, then I can use it.
4. When using technological things, instructions tell me exactly what to do – and only then I can do it.
5. I would rather watch someone work with a complicated technological thing instead of trying to do it myself.
6. I always seem to do something wrong when I try to use technological things.
7. Things with complicated wires and parts that you don‘t understand are technology.
8. I can usually use technological things only when I follow directions

Interacting with Technological Artifact – Tinkering

1. I would rather play around with a technological thing than waste time first reading instructions about how to do it.
2. It is fun figuring out how technological things work without being given instructions to follow.
3. When I see a new technological thing, the first thing I want to do is play around with it to see what it can do.

Interacting with Technological Artefacts - Engagement

1. Finding out how a technological thing works is easiest by reading the manual and playing around at the same time.
2. I like to understand a technological thing by playing with it as well as by reading more about it.
3. To find new features on the technological thing and understand it better, manuals often help if I can't figure it out myself.
4. With a new technological thing, I play with it a bit and read the manual a bit –whichever helps me the most.
5. I always ask permission before I use some new technological thing in case I break it.

Appendix C: *Change in Cronbach's Alpha as Each Item was Deleted*

Sub-scale	Step	Question Removed	Resulting α
Knowledge	1	K5-4	.64
	2	K4-1	.65
	3	K3-6	.66
	4	K3-2	.66
	5	K5-3	.67
	6	K3-5	.67
	7	K4-5	.67
	8	K3-1	.68
	9	K2-2	.68
	10	K1-1	.68
	11	K4-2	.68
	12	K1-8	.68
	13	K4-4	.68
	14	K5-2	.68
	15	K4-6	.68
Capabilities Scenario	1	CS3-6	.69
	2	CS4-5	.70
	3	CS1-5	.70
	4	CS1-6	.71
	5	CS1-1	.71
	6	CS1-8	.71
	7	CS1-3	.72
	8	CS3-4	.72
	9	CS4-6	.72
	10	CS1-2	.72
	11	CS3-7	.72

Sub-scale	Step	Question Removed	Resulting α
Capabilities Likert	1	CL4-3	.86
	2	CL3-2	.86
	3	CL3-4	.86
	4	CL3-7	.86
	5	CL1-5	.85
	6	CL4-6	.85
	7	CL1-2	.85
	8	CL1-7	.85
	9	CL1-6	.85
	10	CL4-7	.84
	11	CL1-1	.84
	12	CL1-4	.84
	13	CL4-5	.84
	14	CL1-3	.83
	15	CL 4-1	.83
	16	CL4-4	.82
	17	CL4-2	.82
	18	CL2-1	.81
Critical Thinking	1	CT2-7	.54
	2	CT2-3	.55
	3	CT1-3	.56
	4	CT1-2	.58
	5	CT2-1	.59
	6	CT1-4	.61
	7	CT1-7	.62
	8	CT1-6	.62
	9	CT1-5	.62

Note: Each step identifies the question removed from the subscale and the resulting reliability. The questions were removed from subscale Capabilities-Likert to shorten the instrument.