ATLAS – ACADEMIC TECHNOLOGY LITERACY ASSESSMENT: A TECHNOLOGY LITERACY MODIFIED DELPHI METHOD STUDY

by

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DEDICATION

Dedication, as defined is the quality of being dedicated or committed to a task or purpose. For those looking to pursue your doctorate to those in the trenches, I offer these few words. The dedication required to complete your doctoral passion is nothing you have experienced before and will probably never experience again. The constant highs of finding those elusive articles that connect your constructs together to those that create your frameworks, then come the lows of days, even weeks of writer's block and nothing making sense. The urges to just quit grows, you are always asking yourself, "why am I doing this." The constant guilt you will feel when you are doing something other than working on your research. The next hour, the next day, your passion for solving the questions you are asking of the research kicks back in and you move forward. Late night conversations with your cohort affirms why you are doing this, and that there is a vast network of people around you that will provide all of the support you need. It is these "behind the scenes" people that make it all possible. Keep the dedication, the passion and most of all have fun during this journey – the rewards are immeasurable.

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ABSTRACT

How technology literate are you? Today, the world and associated technologies are far more complicated than the simple wheel, requiring a technologically literate society and workforce. Despite the widespread agreement about the critical nature of technology literacy and the role it plays in the success for college students, there exists no mechanism for helping students align their technology skills to the skills needed to be successful in college classes. The purpose of this modified Delphi method study was to identify exemplary technology literacy definitions from current technology literacy definitions, develop a basic academic technology literacy rubric and identify steps needed to implement the Academic Technology Literacy ASsessment (ATLAS) rubric system at the program, department, college and university level.

The reduction of 25 technology literacy definitions to 10 technology literacy definition signified a certain level of them being exemplary. All the 10 technology literacy definitions had common threads of problem-solving, communication, responsibility and lifelong. Some of the definitions equated these as the demands of learning in the 21^{st} century. Ten technology experts in higher education were asked how they would align academic technology literacy skills with skill levels. These alignments would be used to create an Academic Technology Literacy ASsessment (ATLAS) rubric. This was accomplished using a modified Delphi method study methodology. Over the course of three rounds, the SME participants aligned 93 out of 131 academic technology literacy skills with skill levels. The integration of the ATLAS was favorable at varying levels at all four areas. The greatest take-away from the responses was that participants observed that they did not see the black and white, digital native and digital immigrant separation of technology literacy. These perceived digital natives were in many cases as technology illiterate as the perceived digital immigrants

This study provides students, faculty, and institutions with an understanding of technology literacy definitions, a tangible ATLAS rubric system that will provide those that feel overwhelmed with technology to identify where they are weak. Administrators will be able to identify actual steps on how to institutionalize the ATLAS rubric at the course, department, college and university level.

CHAPTER ONE

INTRODUCTION

Overview of the Study

According to the Bureau of Labor and Statistics, 69% of the graduating high school seniors choose to enter postsecondary, higher education institutions. In addition to these traditional-age college students, the Department of Education reported 9.8 million (43%) students that are 25 years old and older, which are considered non-traditional students, will also be entering these higher education classrooms (2016). With this mixed-age demographic also comes mixed personal technology literacies. There are the life/learning students, these are individuals that are very literate with life's technology meaning they are experts in social media such as navigating Facebook, Twitter, Instagram (Waycott, Bennett, Kennedy, Dalgarno, & Gray, 2010). They will also encounter students caught in the Digital Native/Digital Immigrant paradox (Prensky, 2012). A Digital Native individual is one that has been tactile with current technology from a very young age, while a Digital Immigrant is an individual that has not been immersed tactically with current technology from an early age (Prensky, 2001). The Digital Native will be native with the technology of today but could become the immigrant with the technology pre-dating them tomorrow. Also, within the mixed-age classrooms, that are becoming more and more commonplace in higher education, there will be students that are technophobic. The individual that is technophobic has an aversion to technology, especially computers (Brosnan, 2002). They will just as soon drop the class at the first sign of technology integration that makes them uncomfortable, and even seek a degree track that does not require the use of technology (M. Jensen, Guttschow, & Hill, 2002). Unfortunately, 43% of surveyed high school students feel unskilled in the use of technology as they move forward into the workforce or continuing their education in some form of postsecondary education such as higher education (Moeller & Reitzes, 2011). Many colleges and universities have identified that technology positively impacted their campuses, having substantial effects on higher education as it is increasingly integrated into academics (Glenn & D'Agostino, 2008). Glenn and D'Agostino (2008) suggest that "technological innovation will have a major influence on teaching methodologies over the next five years. In fact, technology will become a core differentiator in attracting students and corporate partners" (p. 5).

Background of the Study

Historically, technology literacy and the assessment of technology literacy has played an integral part of the educational system since the beginning of formal education (Katz, 1976). In the early 1600s, the foundations of higher education and elementary and secondary education were being cast. As part of this casting, the four fundamental literacies of speaking, listening, reading and writing were linked to the technical labor (literacies) of the apprenticeships of the time. In 1636, the legislature of the Colony of Massachusetts Bay passed an act to establish the first institution of higher education: Harvard College (Goodchild & Wechsler, 1997; Harvard University, 2017; Quincy, 1840). The colony established Harvard College as a theological institution with the primary mission of religious studies (Quincy, 1840). With the creation of Harvard

College, an institution and method of formal higher education had been established. In contrast to the newly created higher education system, there was no such mechanism for formal education that is currently known as kindergarten through 12th grade or K-12. This type of K-12 system was not formally created until 1642 when the Massachusetts Bay Colony created what is believed to be the first compulsory education law (Katz, 1976). Prior to the creation of this system, parents and masters were seen as having a moral obligation to educate the children ensuring “their ability to read and understand the principles of religion and capital law of this country” (Katz, 1976, pp. 11-12), which in simple terms meant that the children would be “taught to read the Bible and come to understand the principles of the Puritan faith (Katz, 1976, p. 12). To ensure that the children’s parents and masters were training their student in “learning and labor” (Katz, 1976, p. 11), selectmen were appointed by the General Court. The selectmen were responsible for meeting with the parents and masters to assess if the children were being educated in the learning and labor required by the Commonwealth. The learning part was the primary responsibility of the parents to instill in them the principles of the Puritan faith, while the masters were responsible for the labor by “apprenticing the children in a trade profitable to themselves and the Commonwealth” (Katz, 1976, p. 12).

Paralleling the moral obligation to educate the children of the written word was also the moral obligation to teach the children to be “trained in some useful calling” (Seybolt, 1917, p. 53), also known as an apprenticeship. Common apprenticeships for boys were “baker, barber and wig-maker, blacksmith, blockmaker, boatman, brasier, carpenter, cooper, cordwainer, currier, farmer, feltmaker, glasier, glover, goldsmith, gun smith, hatter, innholder, joiner, leather-dresser, mariner, mason, merchant, painter, pewterer, pipemaker, printer, saddler, sailmaker, seamstress, shipwright, silversmith, skinner, tailor, turner, weaver, wheelwright" (Seybolt, 1917, p. 91). The primary apprenticeship for girls was housewifery, which included "to sew plaine work and spinning and knitting" and occasionally they were taught the tailor's and glovemakers trade (Seybolt, 1917, pp. 91-92).

With the passage of the Massachusetts Bay Colony Law of 1642 and subsequent revisions in 1647, 1648 and 1650, the learning literacies of reading and writing were formally linked by law to the labor (technology) literacies. Children were now formally being taught to read, write and learn the various levels of technical skills (literacies) associated with apprenticeships such as blacksmithing, mason, printer, shipwright, and wheelwright. The technical skills associated with these apprenticeships of the early to mid-1600s could be closely associated with what is currently referred to as technology/technological literacies.

National Technology Literacy Initiatives

By the 1970s and 1980s, many forms of new technologies started to find their way into K-12 and higher education (Kurland & Kurland, 1987). In the early 1980s, 18% of schools had computers with 125 students per computer, a decade later 98% of schools had computers with 18 students per computer (Cuban, 1993). Paralleling the nationwide introduction of computer technology into K-12 and higher education was the creation of many committees to assess the nation's quality of education, one of which was the National Commission on Excellence in Education (NCEE). In 1981, then Secretary of

Education T.H. Bell established the NCEE to better understand the public's perception of education at all levels. In April of 1983, the NCEE completed the A Nation at Risk (NAR) report outlining their findings and recommendations (Gardner, 1983). Secretary of Education Bell's primary charge to the NCEE was to establish a better understanding of the public's perception of the current state of the nations educational system, from elementary to college. In addition to this primary charge, the commission was also directed to evaluate the following:

- assessing the quality of teaching and learning in our Nation's public and private schools, colleges, and universities;
- comparing American schools and colleges with those of other advanced nations;
- studying the relationship between college admissions requirements and student achievement in high school;
- identifying educational programs which result in notable student success in college;
- assessing the degree to which major social and educational changes in the last quarter century have affected student achievement; and
- defining problems which must be faced and overcome if we are successful in pursuing the course of excellence in education (Gardner, 1983, p.1).

Particular attention was also paid to teenagers, higher education and vocational/technical programs (Gardner, 1983), which is currently known as Career and Technical Education (CTE).

The findings of the report cast a dark shadow over the nation's educational system. The NCEE acknowledged the historical significance and role the nations K-12 and colleges have played. The NCEE emphasized that the landscape was changing and the current erosion and mediocracy of the current system needed to change, and quickly (Gardner, 1983; Westbury, 1984). The report listed 13 indicators of risk, one of which was reported by the Department of the Navy indicated that one-quarter of recruits cannot read at a ninth-grade level, which was the level Navy safety instructions are written. The indicators of risk illustrated how the nation was falling behind at a time when new jobs requiring highly skilled workers utilizing the new and emerging technology of computers. The report emphasized this new emerging technology by listing three examples of this emersion:

- Computers and computer-controlled equipment were penetrating every aspect of our lives--homes, factories, and offices.
- One estimate indicated that by the turn of the century millions of jobs would involve laser technology and robotics.
- Technology was radically transforming a host of other occupations. They included health care, medical science, energy production, food processing, construction, and the building, repair, and maintenance of sophisticated scientific, educational, military, and industrial equipment (Gardner, 1983, p. 10).

One recommendation the NCEE report presented was changes to high school graduation requirements. The NCEE recommended what they call the Five New Basics, which consists of, at a minimum four years of English, three years of mathematics, three years of science, three years of social sciences and one-half year of computer science. In addition to this recommendation, the NCEE also recommended the school day be extended to seven hours and the school year to 200-220 days (Gardner, 1983).

A Nation at Risk (NAR) sheds light on many of the issues the nations educational system was currently facing and would be facing in the future. Up to the school-age generation of the 1980s, every generation before had surpassed their parents regarding economic attainment, literacy, and education. This generation was now being known as the first generation not even to equal the level of achievement of their parents. Paul Hurd, an educational researcher, stated that, "We are raising a new generation of Americans that is scientifically and technologically illiterate”(Gardner, 1983, p. 10).

Following the release of the NAR in April of 1983, support and criticism started almost immediately. A month after the NAR was released, Robert Hersh, Dean of the Graduate school and Professor of education at the University of Oregon wrote an editorial explicitly focused on the nations technological illiteracy and boldly states that “we must acquire technological literacy” (Hersh, 1983, p. 637). Hersh suggested that the nation’s drop in global economic standing as a result of the rapid infusion of technology and the need for, but lack of, high-skilled workers. Hersh advocated for an educational system in need of reform and one that was more responsive, training a more technological literate graduate that understands the benefits of life-long learning. This required the definition of literacy to be rewritten with one that promoted the change of the nation into an increasingly knowledge-based, highly skilled technology literate society (1983).

Paralleling the introduction of the No Child Left Behind (NCLB) Act of 2001, Roblyer and Bennett introduced the theory of a “fifth literacy.” Roblyer and Bennett defined the fifth literacy as “joining basic literacy and computer, technology, and information literacy” (2001, p. 8). The three emerging and often intertwined literacies under the fifth literacies umbrella were computer/digital literacy, technology literacy, and information(al) literacy. Definitions for these three literacies span decades, and with the growth of these literacies, they are becoming increasingly intertwined with related competencies, which make them, confusing, difficult to identify and extract (Jones & Flannigan, 2006; Tyner, 2014).

In the mid to late 1990s these fifth literacies were already starting to develop within K-12 districts and their curriculums, requiring teachers and administrators to look for methods to assess the integration of these new technology literacies. Computer software companies such as Software Publishers Association (SPA) as well as educational associations such as International Society for Technology in Education (ISTE), American Library Association (ALA), International Technology Education Association (ITEA), International Technology and Engineering Educators Association (ITEEA) and the National Assessment of Educational Process (NAEP) had developed, or were in the process of developing assessment mechanisms to address the integration of the fifth literacy into the educational landscape. Assessment of the standard four literacies has been part of educational assessment since the inception of the formal educational system, but the assessment of the fifth literacy was new, requiring new methods of assessment.

With the fifth literacy being technology based, a method of assessment was needed. One of the earliest assessments studies was commissioned by SPA to assess technology in schools and the effectiveness of the technology. The study focused on three sections:

- Effects of technology on student achievement
- Effects of technology on student's self-concept and attitudes about learning
- Effects of technology on interactions involving teachers and students in the learning environment (Sivin-Kachala & Bialo, 1994, p. 6)

The study looked at how Computer-Assisted Instruction (CAI) was being integrated into subjects like mathematics, science, reading, spelling, and writing. Teachers found students performing better using word-processors for their writing versus those not using a word-processor. Using simulation software for science was proving more significant advantages over hands-on lab equipment. Attitudes about learning were increasing especially with lower performing students in spelling. The International Technology Education Association suggests that technology literacy was vital not only to individuals in reaching their goals, but how individuals interact with their communities, the nation, and global economies. They state that "how people develop and apply technology has become critical to future generations" (Association & Project, 1996, p. 6).

Technology Literacy

In the mid-1990s, the Committee on Technological Literacy, the National Science Foundation (NSF), the National Research Council (NRC) and the National Academy of Engineering (NAE) began discussions on the topic of a technologically literate population. Early in the discussion, the group quickly identified that "technology literacy is poorly understood and significantly undervalued" (Greg Pearson & Young, 2002, p.

vii). Technology and technology literacy are considerably more comprehensive than what much of the public understands them to be, and that is, they are much more than simply electronics and computers (International Technology Education Association & Technology for All Americans Project, 1996; Greg Pearson & Young, 2002).

Technology literacy has been and still is, deeply rooted in the social and economic fabric of our nation and to a greater extent, globally. Stated in the Massachusetts Bay Colony Law of 1642, children were to be "apprenticed in a trade profitable to themselves and the Commonwealth" (Katz, 1976, p. 12). Three hundred and sixty-one years later as part of the Technology for All American Project states that "technological literacy, like other forms of literacy, is what every person needs to be an informed and contributing citizen for the world of today and tomorrow. Therefore students, to achieve technological literacy, must develop a broad range of technological knowledge and abilities" (International Technology Education Association [ITEA], 2003, p. 10). Even though each of these statements are separated by 361 years, each of them carries the common foundation that students were to have the appropriate technological literacy to support themselves and the world around them.

Assessment

To better the role that technology literacy plays in students' overall success as learners, it is important to understand not only assessment of those literacies, but assessment in learning in general. Assessment of a learned skill or material has been a part of the educational process since early colonial times. With the passage of the Massachusetts Bay Colony Law of 1642, parents and masters were required by law to educate the children of the colonies, and with the responsibility to educate also came the responsibility to assess what they have learned. Assessment is a derivative of the French word ‘assidere’, meaning to sit beside, and is defined as “the process of collecting data to describe a level of functioning” (G Pearson & Garmire, 2006, p. 64). The parents were to teach the readings and writings of the Puritan faith while the masters were to apprentice the children in a trade, “to sit beside.” The purpose of an apprenticeship was for an apprentice to learn specific skills (technology literacy) allowing them to work their way through the various level from a novice apprentice to a master. The apprentice would be assessed as to their progress by a serviceman. A serviceman would assess the apprentice’s progress based on information collected by the master to the level of their training (Seybolt, 1917). The apprenticeship trades of the colonial times, as well as the apprenticeship trades of today, were all very tactile, and easy to assess. Master, or more commonly known today as Journeymen, could quickly assess if the apprentice was making forward progress. Masters/Journeymen did not assess if the apprentice had the ability or capability to perform a specific task, the apprentice had to actually perform the task in front of the serviceman, illustrating progression to a mastery level.

The K-12 educational systems of today still have a mandatory compulsory education requirement with all 50 states having a minimum grade/age that children must attend (National Center for Education Statistics, 2015). Removed from the current K-12 education process is the requirement that the child’s parents be the primary reading/writing teacher. The teaching responsibility has now been formalized by the public education system and trained teachers at each of the K-12 grade levels. The requirement of the children to be “trained in some useful calling” (Seybolt, 1917, p. 53) has also been removed from the 1640s system. Children in public and private educational systems were no longer required to participate in an apprenticeship. With the removal of the apprenticeship requirement, children had less opportunity to be exposed to new technologies that required them to “develop a broad range of technological knowledge and abilities” (International Technology Education Association [ITEA], 2003, p. 10).

Educational Systems, whether it be Higher Education (Spellings, 2006), K-12, or the servicemen of the early education system, all see the need for assessment of their systems and their student’s success. Students must also have the ability to assess themselves. As Spelling (2006) suggests, Higher Education should be world class, offering workplace skills in an ever-changing world that is altered by technology that allows students to work smarter and learn faster. Developing and implementing a self-assessment tool such as a basic academic technology literacy Rubric allows students to self-assess their technology literacy which has not been afforded to them in K-12 or apprenticeship programs.

Rubrics

Although all states have some form of technology literacy assessment tool at the K-12 level, 43% of surveyed high school students still feel unskilled to use technology as they move forward into the workforce or continuing their education in some form of postsecondary education (Moeller & Reitzes, 2011). Currently, there is no technology literacy assessment mechanism in place at the higher education level. This feeling of being unskilled with technology will continue to follow students until a mechanism is developed to aid students in comparing their basic academic technology literacy skill level to what is required in their coursework.

A rubric is a tool/document consisting of clearly defined criteria and standards/proficiency levels that can be used by faculty and students for the assessment/self-assessment of an assignment(s), project(s), proficiency skill(s), faculty effectiveness, program outcome(s), and is an effective mechanism for providing feedback (Brookhart & Chen, 2015; Hafner & Hafner, 2003; Hassani & Rahman, 2011; Jonsson & Svingby, 2007; Montgomery, 2000; Moskal, 2000; Popham, 1997; Reddy & Andrade, 2010; Rochford & Borchert, 2011; C. Smith, Sadler, & Davies, 2015; Wang & Rairigh, 2006; Yuan & Recker, 2015). A typical rubric has four primary areas: the criteria area is typically located down the left side, the standards or sometimes known as the performance/proficiency levels area is typically located along the top of the rubric, a scoring/grading area is located along the right side, and the area within is where the specific outcomes/skills are located (Dawson, 2017; J. Luft, 1997; Popham, 1997; Reddy & Andrade, 2010; C. Smith et al., 2015).

One aspect that makes rubrics such an effective assessment/self-assessment tool is transparency during the assessment process. When a rubric is used as an assessment tool for a specific course, both faculty and students understand what is being asked of them – faculty populate the rubric with their expectations for the course, and the students understand what is being asked of them. Rubrics provide students a direct understanding of how to achieve the skills needed to move from one level to the next with confidence

(Dawson, 2017; Hack, 2015; Jonsson, 2014; Jonsson & Svingby, 2007; Rosenblatt, 2010; Sadler, 2009).

The use of rubrics has been typically used at the K-12 level, but use at the higher education level is slowly increasing because of the objective and authentic assessment that rubrics provide (Knight, 2006; Reddy & Andrade, 2010). Hafner and Hafner agree with the widespread use of rubrics as assessment tools at the K-12 level but disagree with the widespread use of rubrics at the higher education level except for the discipline of education (2003). Hafner and Hafner associate the limited use of rubrics to the lack of understanding by the faculty as to the use of rubrics as a valid “alternative and authentic” (2003, p. 1510) assessment tool.

The Association of American Colleges & Universities has moved forward with developing the Valid Assessment of Learning in Undergraduate Education (VALUE) rubrics through their Liberal Education and America’s Promise (LEAP) initiative. These 15 VALUE rubrics can be used by institutions to assess their students learning. However; these VALUE rubrics are for the institution to assess their students, not for the student to assess themselves. The AACU VALUE rubric project is a good starting point for institutions to identify their strengths and weaknesses. The 15 VALUE rubrics contain general concept such as civic communication, explanation of issues, access the needed information and responds to conflict and less to do with the assessment of specific skills. Rubrics are a useful tool for measuring student outcomes (Association of American Colleges and Universities., 2009).

Statement of the Problem

The world has been surrounded by technology since the invention of the wheel. Today, the world and associated technologies are far more complicated than the simple wheel, requiring a technologically literate society and workforce. Academia has been grappling with technology literacy since the early 1980s with the introduction of computers into the educational setting (Abbott, 2001; Weiss, Nolan, Hunsinger, & Trifonas, 2006). Since the introduction of computers into the educational setting the personal ownership of computers has gradually increased. In 2015, 88% of college students owned a laptop, and 85% owned a smartphone (Poll, 2015). Helsper and Eynon (2010) suggested that many college freshmen may be skilled at using a computer operating system such as Windows, a word-processing software, an e-mailing software, and the internet, but less skilled with other software such as presentation and spreadsheet programs. Kaminski, Seel, & Cullen (2003) conducted a study at Colorado State University investigating freshman student's self-determined ability to use technology. One of the findings was that faculty presumed that students enrolled in their classes possess basic technology literacy skills; this was not the case. Egan (as quoted in J. Young, 2004, p.12) suggested that "students arrive at colleges knowing how to use a computer or use technology for some purposes, but they are not necessarily the purposes that will make the students successful." Because of this implied knowledge association of students and computer/technology, college faculty and administrators had assumed that students possess the required technical skills to be successful in their courses and college in general (Wilkinson, 2006). Echoing this assumption, McDonald (2004) suggested that post-secondary institutions mistakenly presume that new students arriving at these post-secondary institutions were computer/technology literate. As part of this assumption, it was expected of students that they already have the requisite computer/technology skills to identify, collect, and produce the information required as part of their coursework (McDonald, 2004). However, this assumption has an authentic side in that not all students and faculty are computer/technology literate. McDonald (2004) indicates that classrooms were populated with students, as well as faculty, that were not skilled or knowledgeable with computers/technology and felt overwhelmed. Understanding this dichotomy in post-secondary institutions, McDonald (2004) asserted that post-secondary institutions needed to accept responsibility and guarantee that their students and faculty have the requisite computer/technology literacy skills and knowledge to be successful in the educational programs.

Despite the widespread agreement about the critical nature of technology literacy and the role it plays in the success for college students, no formal mechanisms existed to assist students in self-assessing their technology skills. Further, there exists no mechanism for helping students align their technology skills to the skills needed to be successful in college classes.

Purpose of the Study

The purpose of this modified Delphi method study was to identify exemplary technology literacy definitions from current technology literacy definitions, develop a basic academic technology literacy rubric and identify steps needed to implement the rubric system at the program, department, college and university level.

This study was conducted in three stages, four parts; a single heuristic evaluation, a pilot study of the modified Delphi method study, the modified Delphi method study, and an integration questionnaire. This was done to gain a better understanding of the current technology literacy definitions extracted from multiple empirical research sources, which include The International Society for Technology in Education (ISTE) and State Educational Technology Directors Association (SETDA). A heuristic evaluation was conducted to reduce the list of definitions. A single heuristic evaluation is a method of expert review often used in the field of computer science. A panel of three to five experts in the field of technology related areas was asked to participate in the heuristic evaluation reviewing 25 definitions and reducing them down to a list of 10 for the use in the modified Delphi method study.

In addition to identifying exemplary technology literacy definitions, this study developed a Academic Technology Literacy ASsessment (ATLAS) rubric. As indicated, a rubric is a mechanism used for assessment. The ATLAS rubric consists of rows of technology literacy skills, while the columns consist of skill acquisition levels. An expert panel was surveyed using a modified Delphi method asking participants to match basic academic technology skills such as copy a file, set up a wireless printer, create a document, create and use pivot tables, create a new database, create a new presentation with the appropriate Dreyfus Skill Acquisition level of novice, advanced beginner, competent, proficient and expert skill levels to create a Academic Technology Literacy ASsessment (ATLAS) rubric. So students would know what technology literacy skills they would need to be successful in the course, the rubric could be listed with each participating course with a technology component.

The third and final part of this study focused on the integration of the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, department, college and university level. The purpose of research question number three – integration questionnaire, was to bring forward the processes of how the rubric could be integrated at each of the respective levels. Knowing the technology literacy requirement of a course beforehand would allow students to make informed decisions on whether they possess the requisite technology literacy skills to be successful in the course. Faculty teaching the course could use the ATLAS as a tool for assessing their technology literacy skills as well as the student in their courses. This study provided students, faculty, and institutions with an understandability of technology literacy definitions, a tangible rubric system that could provide those that feel overwhelmed with technology to identify where they are weak, and administrators could identify actual steps on how to institutionalize the rubric system at the course, department, college and university level.

Research Questions

The primary objectives of this modified Delphi method study were to gain a better understanding of the technology literacy construct by identifying exemplary definitions from current technology literacy definitions, create a ATLAS rubric system, and identify steps needed to integrate the rubric system at the program, department, college and university level. The following three research questions helped direct this modified Delphi method study.

RQ1: How do technology experts in higher education define technology literacy?

RQ2: How do technology experts in higher education align academic technology literacy skills with skill levels to create an Academic Technology Literacy ASsessment (ATLAS) rubric?

RQ3: What steps would need to be taken to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, program, department, college and university level?

Significance of the Study

The higher education classrooms of today are complicated and involved, requiring student and faculty to be more fluent in many areas to succeed. Classrooms are less teacher-centered, lecture structured, and more communal and facilitated than before. Classrooms are evolving into student-centered, flipped, active learning where the students take on a greater role in the learning process than before. Classrooms have greater integration of technology such as the national trend of Technology Enhanced Active Learning (TEAL) and similar classroom configurations. The TEAL classrooms not only have a technology focus, but the classes and their pedagogy are also evolving to have a heavy technology integration focus and involved use by students and faculty. Many students are coming from high schools that have not evolved from a less-teacher centered structure to a more student-centered, technology-focused classroom. Students are discovering this new landscape to be mentally/cognitively challenging and overwhelming.

A study conducted in 2009 looked at computer/technology literacy. The study was a longitudinal survey from 2002 to 2008 looking at the success rates of students passing module tests, testing how fluent students were with software packages, or modules such as Word, Excel, PowerPoint, Access and email communication. From 2002 to 2007, 10,360 students participated in the study with an average of 79 % of the students who participated in the study testing their basic computer/technology literacy did not pass the test. The last year of the study 2,245 students participated in the study with 83% not passing the basic computer/technology literacy assessment test (Dednam, 2009).

As the longitudinal study was concluding, another study was being conducted to understand better what students' perceived knowledge versus their actual knowledge of their Information and Communication Technology (ICT) skills were. The study found a significant difference in students perceived ICT knowledge and their actual tested ICT knowledge (Hilberg & Meiselwitz, 2008). Almost three-quarter of the students (73%) perceived their ICT knowledge was much greater than what the tests identified (Hilberg & Meiselwitz, 2008). The study also noted that students that overestimated their knowledge did so at twice the rate as those that underestimated their ICT knowledge (Hilberg & Meiselwitz, 2008). With classrooms and course material having a greater technology integration, the potential for students reaching cognitive overload has increased. This, coupled with students overestimating their perceived knowledge of technology, may create an unfavorable learning environment for students taking courses requiring a certain level of technology literacy.

The significance of this study also includes that technology literacy definitions and academic technology literacy skills were approached pragmatically. Each of the three phases and the development has the potential to help students and faculty reduce cognitive overload and close the gap between perceived and actual ICT/Technology literacy. The first part of this study was to gain a better understanding of the current technology literacy definitions. The second part of the study was to develop an Academic Technology Literacy ASsessment (ATLAS) skills rubric. The significance of this study was to create a mechanism for students, faculty, and anyone associated with basic academic technology literacy skills to assess their current skill level and what was required to move to the next level. This part could also be used by faculty to set specific course outcomes and provided students the framework to successfully meet those outcomes. The third part of this study focused on the implementation of the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, department, college and university level. The significance of this was to explore the feasibility of implementing the rubric system from the perspective of the individuals at each of the respective levels.

Holistically, the significance of this study extends beyond its individual phases. The whole of the study will provide students, faculty, and institutions with an understanding of technology literacy definitions, a tangible rubric that will provide those that feel overwhelmed (cognitively overloaded) with technology to identify where they are weak; administrators can identify actual steps on how to institutionalize the rubric system at the course, department, college and university level. Faculty and students currently in higher education, as well as those looking at entering college, will be able to use the exemplary definitions to understand better the larger picture of technology literacy and how it relates to their specific situations. Faculty and students, as well as those looking at entering college, will also be able to use the ATLAS rubric to identify their technology literacy strengths and capitalize on them systematically. Faculty and students and those looking at entering college will also be able to use the ATLAS rubric to identify their weakness and take appropriate measures to build them into a strength.

Overview of Conceptual Framework

Ravitch and Riggan (2016) define a conceptual framework as, “a conceptual framework is an argument about why the topic one wishes to study matters, and why the means proposed to study it are appropriate and rigorous” (p. 5). Why do researchers choose to study their selected constructs? Maxwell (2012) suggests there are three differing goals that focus researchers as to why they chose what to study. These three goals are personal, practical, and intellectual (scholarly). For some research, a single goal might frame the research, but in most cases, it is a combination or all of the three goals. For this study, it was a personal observation made by the researcher that led to a practical solution driven by scholarly literature and methodologies.

> During the fall semester of my last year teaching, I was working with some students during a lab class when I observed something that happens every day in classrooms all across institutions of higher education. I watched a student who was done with the assignment texting on really small keys at a speed……well let’s say much faster than I could understand how. Two rows over I observed another student struggling with the assignment trying to one-finger type on a standard keyboard with half-inch by half-inch keys. After helping a few more students, I sat back down at the instructor’s computer, and because of this situation, I started wondering about students in this class, my other classes, and students in other classes in general. I started to wonder how one’s own technology literacy may cause them to fall

> behind in their coursework, not because they do not understand the course material, but because they do not possess the proper embedded, ancillary and undisclosed technology literacy skills required to be successful in the course. I am not sure why this interaction made more of a lasting impression that day than any other day, but it did.
>
> While the course material for my course was different, the underlying technology literacy issue was very similar to many others offered at institutions of higher education across the nation and globally. Students enroll in courses with differing levels experiential knowledge of the subject matter, and students understand what is required of them because it is outlined in the course descriptions provided in the college catalog. However; these course descriptions of the material do not explain what ancillary technology literacy skills would be required to successfully support the primary course material. Students have no way of knowing to what level technology is integrated into the course until they are enrolled and attending class. Compounding the selection of courses; courses with the same title and course material may have vastly differing levels of technology integration leaving students selecting and enrolling in classes without any structured mechanism to identify the level of technology literacy required within the course and self-assess if they possess the requisite technology literacy skills required (S. Luft, 2009).

After an exploratory search of the literature regarding technology literacies, technological literacies, technology illiteracy, technology literacy assessment, self-assessment of technology literacy. The exploratory search revealed that very limited research existed regarding these constructs collectively. How was technology literacy being defined? Was there a common technology definition that academia identified with? What would a self-assessment mechanism look like and consist of, and how would it be integrated into academia in a beneficial way?

The concept of this study was to identify technology literacy definitions that were exemplary and develop an Academic Technology Literacy ASsessment (ATLAS) rubric. Once an exemplary definition was identified and the ATLAS was developed, individuals at the course, department, college and university levels were surveyed as to how the

ATLAS could be integrated at their respective levels. For example, another goal Maxwell (2012) suggests is a practical goal. At the heart of a practical solution for this study was a pragmatic paradigm. McCaslin (2008) defines pragmatic as “to locate practical and usable solutions to the stated problem” (p. 5). In its simplest form, a pragmatic paradigm is a solution to a problem. A pragmatic paradigm and the theory of experiential knowledge provided the conceptual framework for this study.

The theory selected to facilitate the solutions was experiential knowledge. Schubert and Borkman (1994) defined experiential knowledge as “information and wisdom gained from lived experience.” This theory was selected because everyone brings a certain level of background knowledge with them that was gained from a lived experience to a situation or formal learning situation such as class. College students and faculty are often positioned in a course and need to identify where their experiential knowledge ends, and the need for new knowledge related to technology literacy begins, for them to be successful in the course they have enrolled.

After the exploratory examination of the current literature, and the classroom observation by the researcher the following three research questions were formed. The central research questions guiding this modified Delphi method study were used to gain a better understanding of the technology literacy construct. The questions were aimed at identifying exemplary definitions from current technology literacy definitions, create a basic academic technology literacy rubric, and identify steps needed to implement the rubric at the course, department, college and university level.

To partly address research question one, a single heuristic evaluation was used to reduce 25 technology literacy definitions down to ten to be used in the first part of the modified Delphi method study. Secondly, a pilot study of the modified Delphi method study was used to test the reliability and validity of the instrument before the modified Delphi method study was used. And lastly, an open-ended questionnaire was used to address research question three as to how the ATLAS could be integrated into the course, department, college, and university. Figure 1 illustrates the paradigm, theory, and research design to address the three research questions identified in this study.

Paradigm

Pragmatic

"to locate practical and usable solutions to the stated problem."

(McCaslin, 2008)

Framework

Knowledge, Experiential Knowledge, and Knowledge, Skills and Abilities (KSA)

Methodology

Heuristic Evaluation

"An informal method of usability analysis where some evaluators are presented with an interface design and asked to comment on it" Nielson and Molich (1990).

Pilot Study

A pilot study is a small-scale representation of a full-scale qualitative or quantitative study that is conducted over a shorter timeframe. The primary purpose of a pilot study is to test for instrument validity and reliability.

Modified Delphi Method Study

A research method used to achieve consensus related to a problem being studied. Modified Delphi method studies typically consist of three rounds to reach consensus.

Integration Questionnaire

A questionnaire is an instrument that collects data for non-statistical analysis (McKee 2015).

RQ1: How do technology experts in higher education define technology literacy?

RQ2: How do technology experts in higher education align academic technology literacy skills with skill levels to create an academic technology literacy assessment rubric?

RQ3: What steps would need to be taken to integrate the academic technology literacy assessment rubric at the course, department, college and university level?

Outcomes

RQ 1: Exemplary definitions of technology literacy.

RQ 2: Academic Technology Literacy ASsessment rubric—ATLAS.

RQ 3: Steps required for integration of academic technology literacy assessment rubric into a course, department, college and university.

Figure 1. Graphical representation of Conceptual Framework
Conceptual framework graphically represented illustrating the framework progression from paradigm to theoretical framework to methodology and ending with the study outcomes. Graphic modeled after Dr. Boehnert's Methodology: Research Design graphic located at **http://cargocollective.com/ecolabs/Method-Diagrams**

Overview of Research Design

The research design for this study was qualitative and quantitative. Addressing the first two research questions, a modified Delphi method study was selected for the consensus building methodology. For research question one, a consensus of exemplary technology literacy definitions was being sought. For research question two, the consensus was being sought for the alignment of basic academic technology literacy skills with the appropriate Dreyfus Skill Acquisition level. The third research question aimed to gather procedural information about the integration of the rubric, so a questionnaire method was selected to gather this information. Procedural information is the process a department has for the integration of a tool, such as a rubric into a course.

The Delphi method is primarily a "structured communication" (Linstone & Turoff, 1975, p.3). This structured communication typically consists of three rounds of information gathering to build a consensus related to a topic (Norman, 1969). The first round typically employs an open-ended questionnaire that was qualitative where themes were created (Hallowell & Gambatese, 2010; Murry & Hammons, 1995; Skulmoski, Hartman, & Krahn, 2007). Instruments used in a Delphi method study typically consisted of open and close-ended questionnaires and Likert scale surveys. A questionnaire is an instrument that collects data for non-statistical analysis, while a survey is an instrument that collects data for statistical analysis (McKee, 2015). The questionnaire is typically open-ended and is used during the first round to collect information.

For this study, two instruments were used to develop the modified Delphi method study instrument. The first instrument was a single heuristic evaluation that was used to reduce 25 technology literacy definitions identified in the literature down to 10. These 10 definitions then became question one of the modified Delphi method study instrument. This evaluation had to be done before the pilot study because the information from the evaluation provided information for the first question of the modified Delphi method pilot study and the primary modified Delphi method study. Nielson and Molich defined a heuristic evaluation as " an informal method of usability analysis where some evaluators are presented with an interface design (technology literacy definitions) and asked to comment on it" (1990, p. 249). The single heuristic evaluation panel was made up of three experts meeting the criteria of being from within higher education in the state of Montana with a strong technical knowledge base.

The panelists analyzed and scored each definition as to if it meets all three heuristics: Engagement, Minimal Language Redundancy, and Human-centric Syntax. The definition was scored per the following: if it meets all three heuristics (3 points), at least two heuristics (2 points), at least one heuristic (1 point), or none of the heuristics (0 points). Once the list of definitions had been identified and verified by participants, question one of the modified Delphi method study was created.

The second development of the modified Delphi method study instrument was a pilot study of the modified Delphi method study. The pilot study was used to test the validity and reliability of the modified Delphi method study instrument. The setting and population for the pilot study were the same as for the primary modified Delphi method study, but the sample, sample method, sample size, data collection, and data analysis differed from the primary modified Delphi method study. Participants for the pilot study were selected from the Teaching Excellence Action Committee (TEACh). The TEACh committee consists of a member from each academic college, one undergraduate and graduate student and a representative from the Library for a total membership of 14. The charge of the TEACh committee is to “improve faculty teaching by allocating funds for faculty development projects; support assessment and outcomes on campus by sponsoring teaching improvement activities; support attendance at instructional development workshops which provide the potential to impact teaching methods on campus” (Montana State University, 2018). All members of the TEACh committee has an intermediate technology literacy level, many of them are well versed in technology literacy, epically within their area of expertise. An understanding of their technology literacy knowledge was assessed during numerous face-to-face committee meetings. Analysis of the data consisted of reviewing comments from participants regarding the overall readability and usability of the instrument as well as the areas that needed to be adjusted before the modified Delphi method study was administered. The pilot study was conducted after the heuristic evaluation had been completed.

The modified Delphi method study was conducted after the pilot study had been completed. This modified Delphi method study consisted of three rounds of information gathering. Round one included the results of the heuristic evaluation as well as a survey with pre-defined items instead of an open-ended question. The pre-defined items for the survey were extracted from an empirical research study of technology literacy skills conducted by Christina Smith (2015) and a list of skills outlined in Office 2016 Simplified (Marmel, 2016). The primary reason for this type of modification was to increase response rates (Custer, Scarcella, & Stewart, 1999). The next two rounds were structured and created from information from each subsequent round. Rounds were suspended when a consensus is achieved, or the round that had been identified as the final round had been reached. A consensus varies from study to study and was discussed in detail in chapter three. For this study, a consensus level of 80% was identified to be appropriate for this type of study.

Participants of the modified Delphi method study consisted of instructors that teach CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office - courses offered at institutions of higher education in the state of Montana. This class is a required course in most associate of arts, an associate of science, an associate of applied science degrees and some bachelor degrees. Those instructors had been identified as the expert for the phase two survey because of their expertise with the topics of computer operation, communication, word processing, spreadsheet and presentation skills.

The integration questionnaire addresses research question three. The premise behind research question three was to bring forward the procedural steps required to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric. The integration questionnaire was administered after the modified Delphi method study had been completed because the participants were working with the results of the completed Academic Technology Literacy ASsessment (ATLAS) rubric. Five academic levels at Montana State University-Bozeman have been identified as the course, program, department, college and university level. A single person from each of the levels was invited to participate in the study. Once all the responses had been collected, each response was reviewed. The review of the draft was to verify that the rubric was integrated as outlined by the steps the participants provided. Table 1 provides the criteria used for the single heuristic evaluation, the pilot study, the modified Delphi method study and integration questionnaire.

Table 1. Criteria for Research Design

	Single Heuristic Evaluation	**Pilot Study**	**Modified Delphi Method Study**	**Integration Questionnaire**
Nature of the Study	Reduce 25 technology literacy definition down to 10 technology literacy definition - Used as part one of modified Delphi method study.	Test modified Delphi method study instrument for validity and reliability.	Identify exemplary technology literacy definitions and create an Academic Technology Literacy ASsessment (ATLAS) rubric.	Procedures required for integration of Academic Technology Literacy ASsessment (ATLAS) systems into a course, program, department, college, and university.
Number of Heuristics used for Evaluation	Three	N/A	N/A	N/A
Participants/Sample	Three experts from academic areas within higher education with a strong technology component.	Three participants from the Teaching Excellence Action Committee (TEACh).	Ten individuals from a cohort of CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office - courses offered at institutions of higher education in the state of Montana.	Five - An individual was selected from each of the five academic areas: course, program, department, college, and university for a total of five participants. Although not considered an administrator, one faculty member from the course level was invited to participate.

Table 1. Criteria for Research Design (continued)

	Single Heuristic Evaluation	Pilot Study	Modified Delphi Method Study	Integration Questionnaire
Analysis Method	The definition was scored per the following: if it meets all three (3 points), at least two (2 points), at least one (1 point), or none of the heuristics (0 points). For example, if a definition meets all three heuristics, it will receive three points per participant for a maximum score of nine. This list of the top 10 may include definitions that only meet two of the heuristics.	Analysis of the data will consist of reviewing comments from participants regarding the overall readability and usability of the instrument as well as the areas that need to be adjusted before the modified Delphi method study can be administered.	Consensus – 80% for part one and part two.	N/A
Anonymity of Participants/Sample	Method of delivery will ensure anonymity.	The anonymity of pilot study participants may be difficult to maintain due to participants are part of a face-to-face committee.	Method of delivery will ensure anonymity.	Method of delivery will ensure anonymity.
Type of evaluation (paper, electronic, interview)	Electronic	Electronic	Electronic	Electronic

Table 1. Criteria for Research Design (continued)

	Single Heuristic Evaluation	**Pilot Study**	**Modified Delphi Method Study**	**Integration Questionnaire**
Evaluation Deliver Method	E-Mail	E-Mail	E-Mail	E-Mail
Number of Rounds/Iterations	One	One	Three	One
Order of Rounds (concurrent or sequential)	N/A	N/A	Sequential	N/A
Timeframe for evaluation	10 Days	13 Days	48 Days	14 Days

Definitions of Terms

Academic Technology Literacy ASsessment (ATLAS) Skills: Are skills such as computer operation, communication, word processing, spreadsheet and presentation skills.

Delphi/Method/Technique/Study: "Structured communication typically consisting of three rounds of information gathered to build a consensus related to a topic" (Linstone & Turoff, 1975, p.3). In this study method, technique and study were used interchangeably.

Experiential Knowledge: "Information and wisdom gained from lived experience" (Schubert & Borkman, 1994)

Expert: "A group of informed individuals" (McKenna, 1994)

and "specialist in their field" (Goodman, 1987)

or "someone who has knowledge about a specific subject" (Davidson, Merritt-Gray, Buchanan, & Noel, 1997)

Fifth literacy: "The joining basic literacy and computer, technology, and information literacy" (Roblyer & Bennett, 2001).

Internet-based applications: Applications/software that reside solely on the internet. These applications are not installed on any local computer. Google Docs, Google Sheets are examples of internet-based applications.

Modified Delphi: For this study, the changing of the method in which the round one survey was created. Round one consisted of a survey with pre-defined items instead of an open-ended question. The primary reason for this type of modification was to increase the response rates (Custer et al., 1999).

Postsecondary educational institutions: Any educational institution after high school that offers a set of courses that culminates with a certificate of completion, proficiency or degree. Technical colleges, cosmetology, two-year and community colleges, four-year colleges and universities would be considered postsecondary educational institutions (National Center for Educational Statistics, 2016).

Pragmatic: "To locate practical and usable solutions to the stated problem" (McCaslin, 2008, p. 5)

Rubric: A rubric is a mechanism used for assessment. Rubrics fall into two primary types: holistic and analytic. A holistic rubric is where the assessment looks at the whole of a project while an analytic rubric looks at the specific performance of a standard at each level (Wiggins, 1998).

Social Media: Forms of electronic communication (such as Web sites) through which people create online communities to share information, ideas, and personal messages (Merriam-Webster, 2016b). Facebook, Twitter, Instagram, and Snapchat are considered social media networking websites.

Subject Matter Expert (SME): "An individual with a deep understanding of a particular process, function, technology, machine, material or type of equipment" (Reh, 2016).

Definitions of digital, information and technology literacy were not included in the list of definition of terms due to the number and variety of definitions for each. A list of these definitions were covered in chapter two, and also listed in Appendix A for digital literacy, Appendix B for information literacy and Appendix C for technology literacy definitions. The narrowing of technology literacy definitions to those seen as exemplary was part of this study.

Assumptions

Assumptions are items that have a relationship to the study that are taken for granted by the researcher (P. Leedy & Ormrod, 2010). This study had many assumptions, first being all the participants of the study understand how a Delphi method study works as explained to them, and that anonymity and confidentiality are vital aspects of the Delphi method design. The second assumption was that since the population of CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office instructors within the university system was moderately small, the instructor will respect each other's anonymity and not seek each other out to see who is participating in the study. The third assumption was that consensus was reached during the Delphi surveys. The fourth assumption was that all the CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office experts selected to be surveyed have the same technology literacy knowledge to identify the basic academic technology literacy skill to populate the rubric. A fifth assumption was related to the CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office experts being truthful about their responses. The final assumption was that the researcher will remain unbiased throughout this study.

Limitations

Limitations of a study are parts of the study that the researcher does not have control of during the study, but believes could affect the study negatively (Gay, Mills, & Airasian, 2011). A limitation that plagues all Delphi studies, to varying degrees, is participant attrition. Delphi studies that are drawn out over a long period of time are subject to participant attrition due to the changing responsibilities and priorities of the participants. A modified Delphi method study was utilized to potentially reduce the attrition rate. The modified Delphi method study used a pre-defined list for the three rounds reducing the round one contact time as well as subsequent rounds. Participant selection was limited to the instructors of the CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office courses offered at institutions of higher education in the state of Montana. Holding the position as the instructor of the course, they were considered the Subject Matter Experts (SMEs) for this study. The limitation was that not all the instructors brought the same level of experiential knowledge to the study. This multi-level knowledge structure of the SMEs may contribute to a consensus that may not be accurate. Inaccuracies may happen if an instructor selects responses on the survey by guessing and not by their experiential knowledge.

Delimitations

Delimitations are within the control of the researcher and typically explain the scope of the study, but also explain what will not be covered by the study (C. M. Roberts, 2010). The objective of this study was to develop a consensus derived definition of technology literacy, and a consensus designed Academic Technology Literacy ASsessment (ATLAS) rubric. ISTE and SETDA provided directional guidance for technology literacy definitions. A 2007 report by SETDA identified the technology literacy definitions utilized by ISTE, STEDA as well as 12 states offering unique technology literacy definitions. This study was delimited to CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office courses offered at institutions of higher education in the state of Montana. Participants of this study were a cohort of instructors that teach CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office course. The basic academic technology literacy skills identified were selected by the researcher from an empirical research study of technology literacy skills conducted by Christina Smith (2015) and a defined list of skills listed in Office 2016 Simplified (Marmel, 2016). An example of some of the basic academic technology skills are: copy a file, set up a wireless printer, create a document, create and use pivot tables, create a new database, create a new presentation. The data collection and analysis lasted approximately 107 days starting in January 2018 and ending May 2018.

Chapter One Summary

Chapter one provided an overview and background of the study. In addition to the overview and background, the statement of the problem, the purpose of the study, research questions, significance of the study and research design were also outlined. An overview and illustrations of the theoretical and conceptual frameworks were also presented along with a list of definitions, limitations and delimitations of the study.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The purpose of chapter two was to define the framework for this study as it was shaped by the literature. Shaping chapter two was accomplished by providing the overview of the research paradigm and framing theories. In addition to this, a historical overview and the evolution/validation of the Delphi study was discussed. Life/learning, digital native/digital immigrant, and technophobic student demographics were also reviewed. Following this section, the literature was reviewed related to the decades of definitions of digital, information and technology literacy and the vast number of definitions emphasizing the need to identify exemplary examples of technology literacy definitions. Lastly, a review of the current state of technology literacy rubric systems that students could use for technology literacy self-assessment was assessed.

Initial review of the literature for this study was conducted using four internet search engines. Google, Google Scholar, Yahoo, and Bing were used to start identifying sources for further review. Four search engines were used because of the different algorithms each used to retrieve information resulting in differing search results. The primary keywords used for the searches were: Delphi study, Delphi method, Delphi technique, technology literacy, technological literacy, technology literacy standard, technology literacy rubrics/matrices, information literacy, digital literacy, life/learning, digital native/digital immigrant, and technophobia. Information identified during the preliminary search was reviewed for either inclusion and saved for further review, or dropped from further review. Sources of the information identified included coursework textbooks/reference handbooks/manuals, books, peer-reviewed and non-peer reviewed journal articles, government reports, non-journal monthly publications, organization websites, directly from the author(s) and dissertation committee members associated with this study. Six-hundred and forty-three documents were collected for further review with most of the information being journal articles. An electronic copy of all documents in the form of a Portable Document Format/File (PDF) was obtained either by download, a scan of the original document or purchased. Online documents were downloaded using the universities library portal. This portal provided access to 236 databases and 121,111 journal titles. The primary databases the articles were obtained from Academic Search Complete, Credo, EBSCO, Elsevier, Emerald Insight, ERIC, IEEE, JSTOR, Project Muse, SAGE, Science Direct, Springer, Taylor & Francis, and Wiley-Blackwell. Dissertation & Theses Global and ProQuest databases were utilized to download identified dissertations.

Cited references ranged in time from 1959 to 2016. Historical overviews of the Delphi Method and a timeline of established digital, information and technology literacy definitions were the reason the reference material goes back to 1959. The majority of the cited material was from 2000-2016.

Theoretical Framework

Academic Technology Literacy was a term identified for this study to encompass skills such as basic computer operation, communication, word processing, spreadsheet and presentation skills. Academic Technology Literacy skills are rooted in the broad theory of knowledge, to a more refined theory of experiential knowledge and finally reduced down to the theory of Knowledge, Skill and Ability/Attitudes or KSA (Al-Khalifa, 2013; Cheney, Hale, & Kasper, 1990). Research question one was difficult to frame with a theory, the theories of experiential knowledge and Knowledge, Skill and Ability/Attitudes (KSA) was used to frame this question loosely. In the current literature, the A in KSA has been referenced as Ability(ies) and Attitude/disposition. For this study, the A referenced Ability. For the experts to select exemplary technology literacy definitions, they possessed a certain level of experiential knowledge and KSA allowing them to relate to the definitions. Research question two focused on technology literacy and assessment of technology literacy. To frame this question, experiential knowledge and KSA had been identified. Research question three focused on the implementation of the basic academic technology literacy rubric within an organization. Framing research question three, organizational change theory was identified. These theories provided the theoretical framework needed to identify technology literacy definitions, develop the ATLAS rubric and implement at the course, department, college and university level.

National Technology Literacy Initiatives

International Society for Technology in Education (ISTE), and State Educational Technology Directors Association (SETDA) are organizations with a K-12 focus, but over the years higher education had adopted some of their methodologies and definition of terms. This study utilized and analyzed definitions from these two organizations as well as others to identify exemplary technology literacy definitions. A large number of the definitions of technology literacy in use today have been developed with some portion of the ISTE and SETDA technology literacy definitions in mind.

ISTE established the National Educational Technology Standards for Students (NETS-S) to help instructors plan and assess activities with integrated technology. The 2007 NET-S had six broad categories; 1) Creativity and innovation, 2) Communication and collaboration, 3) Research and information fluency, 4) Critical thinking, problem-solving, and decision making, 5) Digital citizenship and 6) Technology operations and concepts. For category six, students must demonstrate an understanding of "technology concepts, systems, and operations" (International Society for Technology in Education [ISTE], 2007b). An item in the 2007 standards identified that students demonstrated a sound understanding of how to "transfer current (experiential) knowledge for learning new technologies." For the 2016 NET-S, ISTE completely updated the categories removing any direct word connection to technology within any of the titles. The new seven broad categories were: 1) Empowered Learner, 2) Digital Citizen, 3) Knowledge Constructor, 4) Innovative Designer, 5) Computational Thinker, 6) Creative Communicator, and 7) Global Collaborator (ITSE, 2007b). These evolutionary changes in the NET-S demonstrate technology itself was evolving rapidly. In 1998, the NET-S focused on learning to use technology. This learning to use technology evolved to define the 2007 standards as using technology to learn and had since evolved to the 2016 standards focusing on transformative learning with technology (International Society for Technology in Education [ISTE], 2017).

It was not until 2001 that a system of assessment was mandatory nationwide No Child Left Behind (NCLB). The primary goal for NCLB was to "close the achievement gap with accountability, flexibility, and choice so that no child is left behind" and "improve the academic achievement of the disadvantaged" (No Child Left Behind [NCLB], 2001).

A subpart of the primary act was Title II, Part D: Enhancing Education Through Technology (EETT). The primary goal of the EETT was to:

- to improve student academic achievement through the use of technology in elementary schools and secondary schools.

Two additional goals are in place to aid students in:

- crossing the digital divide by ensuring that every student is technologically literate by the time the student finishes the eighth grade, regardless of the student's race, ethnicity, gender, family income, geographic location, or disability.
- to encourage the effective integration of technology resources and systems with teacher training and curriculum development to establish research-based instructional methods that can be widely implemented as best practices by State educational agencies and local educational agencies (Enhancing Education Thruough Technology [EETT], 2001).

Helping K-12 with the EETT act, financial support was made available to institutions via a grant application process. For K-12 institutions to receive funding, performance goals needed to be developed. Forty-nine states are using the ISTE NETS

(State Educational Technology Directors Association [SETDA], 2007) standards for the framework for state assessment methods for their performance goals to comply with the grant requirements of the EETT. A review of the SETDA's organization website, for an updated report, revealed that the 2007 report was the most up to date on State's technology literacy definitions.

National Assessment of Educational Process (NAEP) produces a report card titled The Nation's Report Card. The report card assesses nine subjects: civics, economics, geography, mathematics, reading, science, Technology & Engineering Literacy (TEL), U.S. history and writing. The report card shows the results of the assessment of grade four, grade eight and grade 12 students. Six of the nine subjects are assessed at each grade level, economics (only grade 12), technology & engineering literacy (only grade 8) and writing are assessed at grade eight and 12. Technology & Engineering Literacy (TEL) was last assessed in 2014. The TEL assessment consists of 20 scenario tasks and 97 questions with a total assessment time of 60 minutes (U.S. Department of Education [DOE], 2013). NAEP is part of the National Center for Education Statistics (NCES).

As stated in A Nation at Risk, "computers and computer-controlled equipment are penetrating every aspect of our lives--homes, factories, and offices" (Gardner, 1983, p. 10), and the educational system at all levels. For the majority of students, skills that they bring with them to Higher Ed that were learned in K-12. For years, students in K-12 were taught keyboarding and word-processing on manual and electric typewriters (Gillmon, 1991). With the introduction of computers into education, computer software replaced manual methods. Greggs Keyboarding® software replaced the electric typewriter, and instead of using the carriage return lever, a return key was pressed. Instead of a physical sheet of paper, an electronic representation was digitally provided. Instead of students manually filing their works, they saved them in a digital format on a piece of plastic called a floppy disk. Another use of an electric typewriter beside teaching keyboarding was word processing. With new software applications for word processing, the electronic typewriter was on the path of becoming obsolete. WordPerfect® is a word-processing software with predefined margins, font, and line spacing, that replaces the physical sheet of paper to write on with an electronic version. Students taking bookkeeping classes were also ushered onto the computer. Accounting procedures and accounting ledgers worksheets were transformed into software packages like Lotus 1-2-3® and Quattro Pro® taking the paper form of the ledger in its simplest form and adapting for the computer (Doost, 1999). These two business-related subjects were not the only subjects that saw the technologies that had integral parts move to the computer. Manual drafting also experienced the transition and transformation to the hardware of a computer and the software programs that operated on them. Computer Aided Design & Drafting (CADD), which was later shortened to Computer Aided Design (CAD) software and AutoCAD® replaced large drafting tables, triangles, T-squares, erasers, lead holders and large drafting arms. Also replaced was the large sheets of paper Draftsmen produced their plans on (Bertoline, Wiebe, Miller, & Nasman, 2005; C. H. Jensen, Voisinet, & Helsel, 1989).

Before these new technologies, students could afford, or schools could provide ledger sheets for bookkeeping, most families had at least a manual typewriter, and to draft at home a T-square, kitchen table and triangles were the only tools needed. With this new form of technology entering schools, students and their families faced challenges affording these new technologies, requiring students to finish their work before leaving school (Seiter, 2008).

Each of these innovations required teachers as well as students to learn how to adapt, and more importantly for the teachers, how to assess what the students were learning. A student may understand the subject matter, and the new technology was not allowing the student to convey that they knew the subject matter, but the student did not know how to use the technology to convey their understanding of the subject. This was the first time in history that not only was the subject matter being taught but also how to use the computer and accompanying software at the same time.

Digital, Information and Technology Literacy Definitions

Rader’s (2002) comprehensive review of the literature related to information literacy, documented the progression of the term from being used primarily by librarians, to common use in K-12 and higher education. This comprehensive review also brought to light the number of differing terminology for technology literacy, information literacy, digital literacy, media literacy and instructional literacy. This was compounded by the fact that some research uses these terms interchangeably, but for others, there was a distinct difference. This “in flux” state of terminology had the potential to cause confusion within the educational and political arenas. The following discourse brought forward some of these definitions. Some of the definitions brought forward were from sources that may be considered less credible than others and were primarily an exercise illustrating the definitional diversity and how this diversity keeps the state of understanding of these concepts in constant flux.

In its basic form literacy can be defined as “the ability to decode and comprehend written language at a rudimentary level, that is, the ability to look at written words corresponding to ordinary oral discourse, to say them, and to understand them” (Kaestle, 1985).

The Fifth Literacy

This fifth literacy was brought forward paralleling the introduction of the No Child Left Behind (NCLB) Act of 2001. Roblyer and Bennett defined the fifth literacy as “joining basic literacy and computer, technology, and information literacy” (2001, p. 8). The three emerging literacies under the fifth literacies umbrella were computer/digital literacy, technology literacy, and information(al) literacy. Definitions for these three literacies span decades, and with the growth of these literacies, they were becoming increasingly intertwined with related competencies, which makes them, confusing, difficult to identify and extract (Jones & Flannigan, 2006; Tyner, 2014).

Digital Literacy.

One of the earliest definitions of digital literacy was by Paul Gilster. Gilster (1997) defined digital literacy as “the ability to understand information and use information in multiple formats from a wide range of sources when it is presented via computers” (p. 1). A more current definition by the American Library Association (ALA) defines digital literacy as “the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills" (Visser, 2014). These two definitions were similar with a concentration of being able to use information. The 2014 definition added the emphasis of being able to use information, which included evaluating it, creating it, and communicating it.

Technology Literacy. Dyrenfurth & Kozak (1991) bring forward one of the earliest definitions technology literacy defining it as

> a concept used to characterize the extent to which an individual understands, and is capable of using technology. Technological literacy is a characteristic that can be manifested along a continuum ranging from non-discernible to exceptionally proficient. As such, it necessarily involves an array of competencies, each best thought of as a vector, that include: Basic functional skills and critical thinking, constructive work habits, a set of generalized procedures for working with technology, actual technological capability, key interpersonal and teamwork skills, and the ability to learn independently (p. 179).

When these new literacies made their way into education, the definitions were lengthy, trying to be all-encompassing. ISTE defined technology literacy as "the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century" (International Society for Technology in Education [ISTE], 2007b). Over two decades later, the definitions were still lengthy but more directed at specific actions such as evaluate, design and create.

Information(al) Literacy. Early definitions of information(al) literacy seem to align with digital literacy more than information(al) literacy. In 1989 ALA defined information(al) literacy as “skills that enable an individual to use computers, software applications, databases, and other technologies to achieve a wide variety of academic, work-related, and personal goals” (American Library Association, 1989). ALA currently defines information literacy as “a set of abilities requiring individuals to "recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information" (American Library Association, 2018) Johnston and Webber (2003) defined information(al) literacy as “the adoption of appropriate information behavior to obtain, through whatever channel or medium, information well fitted to information needs, together with critical awareness of the importance of wise and ethical use of information in society” (p. 336).

Definitions of these three literacies were in some cases narrow, while others were very broad. They were also typically created by the researchers and were individualized and specific to the research they were operationalized for. This makes it difficult for educational institutions to adopt a definition that has greater support than just the author(s) of the document. In the early 1990’s a Delphi Method study was conducted for the National Forum on Instruction Literacy (NFIL) with the goals of “creating a comprehensive definition of information literacy and develop outcome measures” (Doyle, 1992). The study invited 56 experts to help develop a consensus derived information literacy definition and outcomes. The panel developed a definition of information literacy as “the ability to access, evaluate and use information from a variety of sources” (Doyle, 1992). Doyle’s study illustrated that a Delphi study was a viable method for establishing a comprehensive definition.

Student Demographics

The students that populate today's college campuses bring with them a complex and entirely different set of skills than those of the first college students at Harvard College in 1636 (Goodchild & Wechsler, 1997). A student in any educational institution before the mid to late 1970s was only concerned with the standard four basic literacies - listening, speaking, reading and writing. Today, students from young children in elementary school to adult students in postsecondary educational institutions are faced with an ever-increasing, required fifth literacy: technology literacy (Roblyer & Bennett, 2001). International Society for Technology in Education's (ISTE) National Educational Technology Standards for Students (NETS-S) identified the following ten standards for high school students grades 9-12. The ISTE believed that all grade 12 students should be able to demonstrate each of these performances before graduation (International Society for Technology in Education [ISTE], 2007a). The numbers in parentheses following each performance indicator refer to the standards category to which the performance was linked. The categories are:

1. Basic operations and concepts
2. Social, ethical, and human issues
3. Technology productivity tools
4. Technology communications tools
5. Technology research tools
6. Technology problem-solving and decision-making tools

- Identify capabilities and limitations of contemporary and emerging technology resources and assess the potential of these systems and services to address personal, lifelong learning, and workplace needs. (2)
- Make informed choices among technology systems, resources, and services. (1, 2)
- Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and society as a whole. (2)
- Demonstrate and advocate for legal and ethical behaviors among peers, family, and community regarding the use of technology and information. (2)
- Use technology tools and resources for managing and communicating personal/professional information (e.g., finances, schedules, addresses, purchases, correspondence). (3, 4)
- Evaluate technology-based options, including distance and distributed education, for lifelong learning. (5)
- Routinely and efficiently use online information resources to meet needs for collaboration, research, publication, communication, and productivity. (4, 5, 6)
- Select and apply technology tools for research, information analysis, problem-solving, and decision-making in content learning. (4, 5)
- Investigate and apply expert systems, intelligent agents, and simulations in real-world situations. (3, 5, 6)
- Collaborate with peers, experts, and others to contribute to a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate information, models, and other creative works. (4, 5, 6)

All college students fall into two large and simplistic categorizations defined by age. These general college student age group demographics are traditional and non-traditional college students. The National Center for Education Statistics (NCES) defines a traditional-age college student as an individual that is 24 years old or younger, while a nontraditional age college student is 25 years old or older (National Center for Educational Statistics, 2015). Many students enrolled in postsecondary educational institutions that fall into the traditional or nontraditional demographic also belong to at least one of the following technology-laden demographics:

- Life/Learning
- Digital Native/Digital Immigrant
- Technophobic

The life/learning students are individuals that are very literate with life's technology, meaning they are very knowledgeable and skilled with social media such as navigating Facebook, Twitter, Instagram, but are unskilled to use, but presumed to be, technology literate (Waycott et al., 2010). They will also encounter students caught in the Digital Native/Digital Immigrant paradox. A Digital Native individual is one that has been tactile with current technology from a very young age, while a Digital Immigrant is an individual that has not been immersed tactically with current technology from an early age (Prensky, 2001). The individual that is technophobic has an aversion to technology, especially computers (Brosnan, 2002).

Life/Learning

Students pursuing a postsecondary education entered these respective institutions with varying levels of life and learning experiential knowledge. In the regards to each of these as related to basic academic technology literacy skills, students have greater life technology literacy then learning technology literacy. This greater life technology literacy stems from the fact that the life technology literacy was always present through social communication such as social media applications, while the learning technology literacy was only intermittently present (Corrin, Lockyer, & Bennett, 2010; Waycott et al., 2010). An empirical study conducted by Waycott et al. (2010) identified that college students, as well as teachers, identify and use their life and learning technology literacy much differently and were much more fluid with life than with their learning technology literacy. Life technology literacy is better known as social media or social networking skills. At the heart of social media are internet-based applications such as Facebook, Twitter, YouTube and Instagram (Knight-McCord et al., 2016). Students with a Facebook account found themselves being more comfortable changing and managing their account than creating a pivot table in their current spreadsheet assignment (Corrin et al., 2010). This comfort level was simply because of the amount of time using the applications versus the amount of time using learning applications. The use of life applications was a perpetual effort that typically had emotional rewards. In contrast, learning applications were typically a single occurrence, such as a group presentation. Once the presentation was over, it was done with no perpetual effort and no emotional attachment; it was simply an assignment for a grade.

Learning technology literacy was the use of applications that were a combination of internet-based applications such as Learning Management Systems (LMS) used by many universities for course content delivery and software such as word-processing and spreadsheet applications. Common LMS systems are Blackboard, Desire 2 Learn (D2L) and Moodle. Many university libraries have internet-based applications as a means for students to access research databases. Non-internet learning applications would be applications such as word-processing, spreadsheets, databases and presentation software. Gurung and Rutledge (2014) used the term personal use for life and educational for learning. In addition to using differing terms for life/learning, they grouped them as digital learners. Although their personal use of technology was widespread, Gurung and Rutledge (2014) suggest that digital learners were not equipped with the types of academic skills that were essential for learning. Because so-called digital learners were basic technology users having functional skills of game playing, social networking, texting, and surfing information on the Web, their learning engagement was limited, lacking technology-mediated productivities such as self-created learning content, research skills, and using computers as cognitive tools.

Digital Native/Digital Immigrant

According to Prensky (2001), everyone falls into one of two demographics determined by a person's technology literacy – you were technology literate (a digital native) or technology illiterate (a digital immigrant). A digital native may have been hands-on with technology at a very young age such as informally working with a parent at the computer or playing a computer game and wanting to use the technology.

Prensky (2001) defined a digital native as "'native speakers' of the digital language of computers, video games and the Internet " (p.1). Digital Natives were born into the digital world, unlike the Digital Immigrants who have had to learn the digital language later in life. Digital technology was always part of everyday life for the Digital Native (Wolsey & Grisham, 2011).

Digital immigrants may have found themselves with a lesser understanding of digital technology as opposed to their digital native counterparts. The digital immigrants may have found themselves needing a formal class to introduce them to the unknown digital technology that surrounds them (Helsper & Eynon, 2010). These classes would be full of other immigrants finding themselves in the "deep end of the pool" with everyone else that doesn't know how to technologically "swim." Prensky's foundational theory for this digital age difference was the perceived idea that students of today "think and process information fundamentally differently from their predecessors " (2001, p. 1). The use of digital native and immigrant terminology, which in turn categorizes, or in more defining terms, divides and separates everyone into two distinct demographics groups due to their technological literacy.

Since Prensky's 2001 article established the digital divide of digital native and immigrants, there have been several articles that have embraced the terminology but also several that criticize it for its simplistic generalizations and categorizing of generations. One of the most comprehensive articles criticizing the construct of Digital Native/Digital Immigrants reviewed the construct over a 10-year timeframe. Koutropoulos (2011) critically reviewed Prensky's digital native/immigrant theory from 2001 to 2011.

Koutropoulos also looked at articles that didn't specifically use the digital native/immigrant terminology but instead used other terms to categorize generations in the same manner that Prensky had done.

Koutropoulos's (2011) article first took aim at the overgeneralization this younger, tech-savvy generation that grew up spending thousands of hours playing video games and even more time watching TV and Instant Messaging (IM'ing), and the educational systems' of today were ill-prepared for this new type of learner. Koutropoulos (2011) also criticized the digital native and the use of Google for a search without having the informational literacy to determine the effectiveness of the search. Koutropoulos (2011) concluded that "there are two factors in play here; first are student attitudes toward instruction, and the role of technology in instruction; and second the nature of personal technology when mixed with instruction" (p. 530). He goes on to point out that "technology is not necessarily ruled out; however, it needs to tie into the subject of the class, in other words, is the application of this technology appropriate for the subject matter" (p. 530).

Technophobia

Many things in life cause anxiety, discomfort, avoidance of a situation or a specific object, and for some, debilitating fear; a phobia is one of these things. The Mayo Clinic (2016) defined a phobia as a long-lasting personal internal fear of a situation or a physical object overpowering the individual with anxiety that produces strong mental and physical reactions. In many cases, this fear will debilitate the individual preventing them from performing normally at work and in social situations.

Common phobias that are easily recognized are claustrophobia - the fear of confined spaces, arachnophobia - the fear of spiders, acrophobia - the fear of heights, aerophobia - the fear of flying, but many do not realize there is a phobia of technology called technophobia. Technophobia, as defined by Merriam-Webster's dictionary, is the "fear or dislike of advanced technology or complex devices and especially computers" (Merriam-Webster, 2016a). Unlike arachnophobia where you fear all spiders, technophobia is a broad definition because someone can have technophobia but still be fine driving a car or operating an ATM but was unable to use a smartphone or an e-reader in a class that requires, and only uses an electronic version of the textbook. For the general population, that has no or a mild case of a phobia, does not understand the physical and mental control a phobia can have. A student that was enrolled in a course may drop the course as soon as they encounter any form of technology used within the course that causes them any form of discomfort. Moreover, for some, technophobia can be so severe that a student will choose courses and subsequently a career that is void of any technology (M. Jensen et al., 2002).

As students in the Life/Learning, Digital native/Digital Immigrant (digitals) and technophobic demographics enter postsecondary educational institutions, they have enrolled in courses to create a better understanding of concepts such as college algebra, college writing, psychology or explorations in literature. Students understand that they will be learning these concepts at relatively the same speed as the other students; what was not explained was the level of academic technology literacy knowledge/skills that would be required for students to be successful. Life/learning students may have been well versed if some of the instructors of these courses require them to interact using social media but may fall prey to the pressures of sub-par technology literacy skills. The digitals (immigrants and natives) have seen their technology literacy knowledge/skills as more of a sine wave than a constant, dependable skill that will aid them in being successful in the course. The technophobe will feel the most pressure of not having the required academic technology literacy knowledge/skills to successfully pair their learning of the course material with their technology literacy level. Digital natives and technophobes will be able to use the rubric to self-assess their knowledge/skills and, if necessary, seek appropriate training to improve their technology literacy. This assessment, along with the rubric identifier on the course description, would enable all student to identify if they could be successful in the course.

The student demographics of life/learning, digital native/immigrant and technophobe students all have knowledge, and more particular experiential knowledge in common. All the students in these three demographics have knowledge of the abilities of smartphones. They will each have differing levels of experiential knowledge of the uses of the smart phone. It is these differing levels of knowledge that has defined their respective demographics.

Knowledge

Knowledge has been defined many ways by many different scholars. This stems from the fact that knowledge is a complicated construct to dissect to its elementary parts and is respective to the scholar's background/field of study and research. An engineer may have defined knowledge differently than an economist or a historian. Davenport and

Prusak (1998) defined knowledge as, "Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information." (p. 5) In addition to their definition, Davenport and Prusak suggest that knowledge was constructed from data which was assembled into information which in turn created the foundation for knowledge (1998).

Levels of Knowledge. Working with Davenport and Prusak's constructs of data, information, and knowledge, a learner with a limited amount of data would also have a limited amount of information resulting in limited knowledge or surface knowledge. In contrast, a learner that had a greater depth and breadth of data would have large amounts of information, and thus, have greater/deeper knowledge (De Jong & Ferguson-Hessler, 1996). Dreyfus and Dreyfus (1980) suggested that students cannot go from beginner (novice) to expert without three stages in between: advanced beginners, competent and proficient. The acquiring of knowledge, and the amount of practice using that knowledge, delineated the level at which a student could declare their skill. Dreyfus and Dreyfus may have considered a learner with the surface knowledge to be a novice; someone with limited experience with the subject and that needed continual direction and instruction to complete an elementary task. On the other end of Dreyfus's Five Stages of Adult Skill Acquisition model, a learner with a deep knowledge would be considered an expert; someone that has considerable experience and a deep understanding of the subject and does not need direction or instructions to complete complex tasks. Davenport and Prusak (1998) also suggest that knowledge was obtained and matures because of experiences. This experienced-based knowledge provides perspective for the learner when encountering a new situation with similar attributes; allowing for more refined understanding and problem-solving (Bransford, Brown, & Cocking, 1999).

Experiential Knowledge

Schubert and Borkman (1994) defined experiential knowledge as “information and wisdom gained from lived experience” (p. 228). This gained knowledge of life’s experiences exists with everyone but differs between individuals. All college students bring a certain level of experiential knowledge with them. This experiential knowledge, their toolbox for life, is a collection of life skills and academic knowledge which would include their literacy of technology. Borkman (1976) links a pragmatic paradigm and the theory of experiential knowledge together by suggesting that each of them emphasize “concrete observable results that work” (p. 449).

Fazey, Fazey, Salisbury, Lindenmayer, and Dovers (2006) suggested that experiential knowledge can be broadly defined into two groups, those with greater expertise, and those with lesser expertise. Individuals with greater knowledge gained from experiences found it easier to structure data into organized information.

Knowledge, Skills, and Abilities (KSA)

Experience and experiential knowledge were integral parts of the Knowledge, Skills, and Abilities (KSA) model. The origin of the KSA model was unknown, but the individual components of knowledge, abilities, and experience were collectively used in a 1972 position paper. In 1972, with the aid of industry and educational institutions, the

Association of Computing Machinery (ACM) prepared a position paper looking at developing course outlines for information systems design courses and specializations of information systems design in existing programs (Ashenhurst, 1972). The curriculum committee, comprised of industry and educational members, developed lists of knowledge and abilities they felt students might be expected to achieve as well as experiences they may have already developed from other coursework. Critical elements of the lists were that all of the knowledge and abilities listed were measurable within the academic environment, and the knowledge, abilities, and experiences would collectively aid the students' in the preceding courses (Ashenhurst, 1972). By 1978, skill replaced experience forming the three constructs of the KSA model: Knowledge, Skills, and Abilities (Cheney et al., 1990).

The KSA model breaks down into the personal attributes a person/learner possesses to perform a job or task (Al-Khalifa, 2013; Bakarman, 2011; Cheney et al., 1990; Kay & Moncarz, 2004). The U.S. Department of Veterans Affairs defined the three attributes of a KSA as:

> **Knowledge:** an organized body of information; for example, the knowledge of policies and procedures/rules and regulations.
>
> **Skills:** the manipulation of data and/or objects; for example, skilled to operate a computer and computer software.
>
> **Ability:** the capacity to perform an activity or task; for example, able to operate a computer and computer software (U.S. Department of Veterans Affairs, 2016).

These connected attributes were the knowledge of a subject, the tactile skills and inherent ability to employ the knowledge of the subject and to successfully complete the job or task. To illustrate this for example, a person that has collected the necessary data on building a house, then related the information into knowledge by connecting on how the roof connects to the walls and how the walls connect to the foundation, may not possess the tactile skills and inherent ability to construct a house.

Criteria for Literature Selection

The literature review for the digital, information and technology definition section of this study was initiated using Google, Google Scholar and Universities Library's article and research database search engines. While this review of these three constructs was thorough, it was not exhaustive. Keywords used for the initial selection were digital literacy, information literacy, and technology literacy. The rationale for reviewing digital, information and technology was to highlight how interchangeable the three constructs were. The rationale for focusing on technology literacy instead of information was that information, and digital literacy was viewed as a having a narrower focus than technology literacy (Ingerman & Collier-Reed, 2011). For this study, a focus on technology literacy allowed for a broader application. The benefit of reviewing the three constructs was to collect all three groups of definitions in a single document. The primary objective of the searches was to find definitions of each of the literacies. Results of the searches were reviewed for relevancy, and if deemed to be relevant, the information and document was downloaded from the search engine to a local hard drive/folder for further review. Any of the data that was not in a Portable Document

Format (PDF) file, such as information on a webpage, was copied from the webpage and pasted into a word processing software and saved as a pdf file.

The collected documents consisted mostly of journal articles retrieved from databases such as Taylor and Francis, JSTOR, SAGE, Elsevier and Routledge. Other documents were retrieved from websites hosting the documents such as SETDA, ISTE, ALA, ITEEA, ACRL and some state and federal websites. This search process narrowed the focus from a general internet search to sites specific to education.

A total of 1,091 documents were downloaded and stored on a local hard drive. Adobe Acrobat 11 Pro was utilized to data mine the documents for digital, information and technology literacy definitions. To mine the data, the advanced search function under Edit was used to identify the search location and word or phrase to be used. The word that was used was the root of define(d) and definition: defin. Using defin as the word being mined from the data, a total of 500 document and 9,321 instances of defin were identified. The process from this point was to select each of the documents and "read" around the word defin. When a document was selected for review, the article opens and highlights all instances of the word or phrase within the document. Reading around the word means to read the paragraph before the instance and a paragraph after the instance. When a definition was located the citation information and definition was recorded. This data mining process identified 15 definitions for digital literacy, 15 definitions for information literacy and 14 definitions for technology literacy.

Digital Literacy

Digital literacy was an immense and ever-encompassing term. Many of the terminology/definitions related to technology and information literacy could loosely be grouped under digital literacy. With the ever-increasing need for students in K-12 to be digital literate, legislative steps have been taken to ensure this is addressed at the K-12 level. Currently, Senate Bill 1177 has passed the Senate and was awaiting further approval. Every Child Achieves Act of 2015 reauthorizes and amends Elementary and Secondary Act of 1965(ESEA). Amendments S.Amdt.2153 to S.Amdt.2089 addresses students' access to digital literacy learning resources and provisions to make sure students graduate with enough digital literacy skills to enter the workforce or postsecondary education. Leslie Proddy, a librarian, and president of the American Association of School Librarians stated "Now we are acknowledging that being a digital native does not mean that you are digitally literate" (as cited in Roscorla, 2015). While students may know how to use smart devices, that does not translate to an innate ability to analyze, interpret or develop new technology. This vote showed that policymakers were considering the ramifications of a society without digital literacy experts (Roscorla, 2015). This legislative activity and attention towards K-12 will inevitably invoke similar conversations at the higher education level with a growing number of high school students utilizing early college high school or dual/concurrent enrollment opportunities ("Every Student Succeeds Act of 2015,").

Table 2 is a comprehensive list of digital literacy definitions spanning 17 years. This comprehensive list illustrates the evolution of the definition of digital literacy as technology has evolved.

Table 2. Digital Literacy Definitions

Source	**Definition – Digital Literacy**
(Gilster, 1997, p.1)	the ability to understand information and use information in multiple formats from a wide range of sources when it is presented via computers.
(Holum & Gahala, 2001)	the ability to attain deeper understanding of content by using data-analysis tools and accelerated learning processes enabled by technology
(Saedi, 2003)	a means for ascertaining the competency of an individual to function in the workplace
(Martin, 2005, p.135)	the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process
(Buckingham, 2006, p.265)	a minimal set of technical skills that enabled users of technology to operate effectively and to perform basic tasks.
(Jones & Flannigan, 2006)	a person's ability to perform tasks effectively in a digital environment, with the term "digital" meaning information represented in numeric form and primarily for use by a computer. Literacy includes the ability to read and interpret media (text, sound, images, et. al.), to reproduce data and images through digital manipulation, and to evaluate and apply new knowledge gained from digital environments.

Table 2. Digital Literacy Definitions (continued)

Source	**Definition – Digital Literacy**
(Martin, 2006, p.19)	is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analysis and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process.
(Martin & Grudziecki, 2006, p. 255)	the awareness, attitude and ability of individuals' to use digital tools for communication, expression and social action in specific life situations.
(O'Brien & Scharber, 2008, pp. 66-67)	Socially situated practices supported by skills, strategies and stances that fostered an individual's ability to represent and understand ideas with numerous modalities and digital tools
EU Digital Literacy: Skills for the Information Society, http://ec.europa.eu/ information_society/tl/edutra/skills/index_en.htm (accessed January 31, 2010)	involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.
(Hobbs, 2010, p. vii)	as a constellation of life skills that are necessary for full participation in our media-saturated, information-rich society.
(Hague & Payton, 2011)	access to a broad range of practices and cultural resources that you are able to apply to digital tools. It is the ability to make and share meaning in different modes and formats; to create, collaborate and communicate effectively and to understand how and when digital technologies can best be used to support these processes.

Table 2. Digital Literacy Definitions (continued)

Source	**Definition – Digital Literacy**
(Littlejohn, Beetham, & McGill, 2012, p. 547)	means the capabilities required to thrive in and beyond education, in an age when digital forms of information and communication predominate.
(Visser, 2014)	the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills.
California ICT Digital Literacy Assessments and Curriculum Framework p. 3	ability to use digital technology and communications tools, and/or networks to access, manage, integrate, evaluate, create and communicate information in order to function in a knowledge society.

Information Literacy

In 1987, the president of the American Library Association (ALA) assembled a 13-member committee to address information literacy. The committee was charged with three objectives (American Library Association, 1989):

1. Define information literacy within the higher literacies and its importance to student performance, lifelong learning, and active citizenship.
2. To design one or more models for information literacy development appropriate to formal and informal learning environments throughout people's lifetimes.
3. To determine implications for the continuing education and development of teachers.

American Library Association (1989) operating definition and the doctrine of informational literacy was:

> A set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information. Producing such a citizenry will require that schools and colleges appreciate and integrate the concept of information literacy into their learning programs and that they play a leadership role in equipping individuals and institutions to take advantage of the opportunities inherent within the information society. (p. 2).

Even though the term information literacy has been floated around since the 1970s, it was this definition and doctrine that has been instrumental in setting the stage for information literacy.

In the same report the ALA identifies that information literacy was closely related to information technology and defines information technology as: “skills that enable an individual to use computers, software applications, databases, and other technologies to achieve a wide variety of academic, work-related, and personal goals” (American Library Association, 1989, p. 3).

As part of the final report for the National Forum on Information Literacy, Doyle (1992, p. 3) defined information literacy as: "the ability to access, evaluate, and use information from a variety of sources." The report also identified characteristics of an information literate person. These 10 characteristics are (Doyle, 1992, p. 2):

- Recognizes the need for information
- Recognizes that accurate and complete information is the basis for intelligent decision-making
- Formulates questions based on information needs
- Identifies potential sources of information
- Develops successful search strategies

- Accesses sources of information including computer-based and other technologies
- Evaluates information
- Organizes information for practical application
- Integrates new information into an existing body of knowledge
- Uses information for critical thinking and problem solving

The Society of College, National and University Libraries (SCONUL) defined information literacy as: "an awareness of how they gather, use, manage, synthesize and ethically create information and data and will have the information skills to do so effectively"(Bent & Stubbings, 2011).

For more wide-spread integration of information literacy, the concept needed to make it out of the perceived confines of being only a library function and make it into the academic arena (Webber & Johnston, 2000). With links to library services as well as an academic linkage, technology and information literacy could play a valuable role in the advancement of students' technology and information literacy skillsets.

Table 3 is a comprehensive list of informational literacy definitions spanning 18 years. This comprehensive list illustrates the evolution of the definition of information literacy as technology has evolved.

Table 3. Information Literacy Definitions

Source	**Definition – Information Literacy**
(Tessmer, 1985)	is the ability to effectively access and evaluate information for a given need
(American Library Association, 1989, p. 3)	skills that enable an individual to use computers, software applications, databases, and other technologies to achieve a wide variety of academic, work-related, and personal goals

Table 3. Information Literacy Definitions (continued)

Source	**Definition – Information Literacy**
(ALA, 1989)	the ability to recognize when information is needed and the ability to locate, evaluate, and use the needed information effectively.
(Breivik & Gee, 1989)	is the ability to effectively access and evaluate information for a given need. It includes an integrated set of skills (research strategy and evaluation) and knowledge of tools and resources.
(Dyrenfurth & Kozak, 1991, p. 139)	A concept used to characterize the extent to which an individual understands, and is capable of using technology
(Doyle, 1992, p. 3) Delphi Method derived definition	is the ability to access, evaluate, and use information from a variety of sources
(Fortier, Potter, Grady, Lohr, & Klein, 1998, p. 1)	is the ability of an individual, working independently or with others, to use tools, resources, processes, and systems responsibly to access and evaluate information in any medium, and to use that information to solve problems, communicate clearly, make informed decisions, and construct new knowledge, products, or systems.
([ACRL] Association of College Research Libraries, ,, 2000)	a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information
([ACRL] Association of College Research Libraries, ,, 2000)	the set of skills to access, evaluate, organize, and use information from a variety of sources
(ACRL Association of College Research Libraries, ,, 2000, p. 2)	a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.

Table 3. Information Literacy Definitions (continued)

Source	**Definition – Information Literacy**
(Holum & Gahala, 2001)	the ability to access and use information, analyze content, work with ideas, synthesize thought, and communicate results
(Koning, 2001)	as locating, evaluating, managing, and using information effectively from a range of sources for problem solving, decision making, and research
(ICT Literacy, 2002, p. 16)	ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society.
Association of College & Research Libraries (2003)	a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the information needed.
(Johnston & Webber, 2003)	is the adoption of appropriate information behavior to obtain, through whatever channel or medium, information well fitted to information needs, together with critical awareness of the importance of wise and ethical use of information in society.

Technology Literacy

The Enhancing Education Through Technology Act of 2001 brought technology literacy definitions to the forefront. Two of the predominant organizations that established definitions and standards to comply with the act were The International

Society for Technology in Education (ISTE) and State Educational Technology Directors Association (SETDA).

The International Society for Technology in Education (ISTE) (International Society for Technology in Education [ISTE], 2007b) defined technology literacy as: "the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century." In addition to ITSE's definition the State Educational Technology Directors Association (SETDA) defined technology literacy as "the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century" (2007, p. 1).

Helping comply with the K-12 performance goals of NCLB and EETT, each state chose to adopt the technology definitions of ITSE, SETDA, self-define or chose an alternative technology literacy definition. Twenty-one states (42%) adopted ITSE's definition, eight states (16%) adopted SETDA's definition, and the remaining 21 states (42%) chose to self-define or select an alternative definition. Appendix D identifies the organization and their choice of technology literacy definition.

With nearly 50 of the states K-12 governing bodies choosing to self-define or chose another technology definition other than ITSE's or SETDA's definition illustrates the need for a uniform technology definition. The issue of a uniform technology definition does not exist at the K-12 level. For the most part, the only definitions of technology literacy that students may have brought with them from K-12 are those which were part of State and Federal initiatives.

Due to Higher Education being an option beyond K-12, Higher Education felt that technology literacy was something that students should come with and not be taught as a remedial course. Because K-12 students were coming to Higher Education without this, researchers struggled with defining technology literacy. Many researchers molded other definitions to self-define in order to operationalize one to fit their specific definition.

Colorado's Department of Education (Colorado Department of Education, 2009) defined technology literacy as the ability to responsibly use appropriate technology to:

- Communicate
- Solve problems
- Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas
- Acquire lifelong knowledge and skills in the 21st century

Colorado's Department of Education was broadly consistent with ISTE's definition of technology literacy, but some are less direct with their definition.

Advancing Excellence in Technology Literacy (International Technology Education Association [ITEA], 2003) defined technology literacy as: "the ability to use, manage, assess, and understand technology." This definition provides a very broad definition but offers little specific definition structure for those looking for a definition to provide opening structure for outcomes assessment. This definition could encompass anyone that could operate an electric pencil sharpener, would be considered technology literate.

McMillian (1996) defined technology literacy as: “the knowledge and ability a person has to use computers,” and Leu & Kinzer (2000) defined technology literacy as: “the ability to gather, organize, analyze, and report information using technology.” McMillian’s definition fell short in that, at what level of knowledge and ability does a person need to operate the computer; does turning it on and playing solitaire, then turning it off constitute someone being technology literate. Leu & Kinser’s definition fell more in line with information(al) technology literacy definition than technology literacy.

Judson (2010) did not offer any definitions of technology literacy, but more of a conversation of, now that we have these definitions, how do we identify those that are less technology literate from those that are more fluent with technology, and therefore are considered more technology literate.

Table 4 brings forward 15 other technology literacy definitions spanning 16 years, from 1991 to 2009, illustrating the complexities associated with creating a unified definition.

Table 4. Technology Literacy Definitions

Source	Definition – Technology Literacy
(Dyrenfurth & Kozak, 1991, p. 179)	a concept used to characterize the extent to which an individual understands, and is capable of using, technology. Technological literacy is a characteristic that can be manifested along a continuum ranging from non-discernible to exceptionally proficient. As such, it necessarily involves an array of competencies, each best thought of as a vector, that include: Basic functional skills and critical thinking, constructive work habits, a set of generalized procedures for working with technology, actual technological capability, key interpersonal and teamwork skills, and the ability to learn independently.
(US Department of Education [DOE], 1996)	Computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic
(US Department of Education [DOE], 1996, p. 5)	the ability to use computers and other technology to improve learning, productivity, and performance
(McMillan, 1996)	the knowledge and ability a person has to use computers.
(Dugger, 1997)	the ability to use, manage and understand technology
(Selfe, 1999, p. 11)	a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.

Table 4. Technology Literacy Definitions (continued)

Source	**Definition – Technology Literacy**
([ACRL] Association of College Research Libraries, ,, 2000)	rote learning of specific hardware and software applications.
(Leu & Kinzer, 2000)	the ability to gather, organize, analyze, and report information using technology.
(Dugger Jr, 2001, p. 514)	is the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.
(International Technology Education Association [ITEA], 2003)	the ability to use, manage, assess, and understand technology.
(Hansen, 2003, p. 117)	an individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment
(Shackelford, Brown, & Warner, 2004, p. 7)	design, develop, control, use and assess technological systems and processes
(International Society for Technology in Education [ISTE], 2007b)	the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.

Table 4. Technology Literacy Definitions (continued)

Source	**Definition – Technology Literacy**
(Colorado Department of Education, 2009)	the ability to responsibly use appropriate technology to: • Communicate • Solve problems • Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas • Acquire lifelong knowledge and skills in the 21st century

The rationale for reviewing digital, information and technology literacy instead of just technology literacy was their interchangeable and alignment use in the literature. For example, Buckingham (2006) defined digital literacy as "a minimal set of technical skills that enable users of technology to operate effectively and to perform basic tasks" (p.265). Buckingham's digital definition seemed to align better with technology literacy than digital literacy. Dyrenfurth and Kozak (1991) defined information literacy as "a concept used to characterize the extent to which an individual understands, and is capable of using technology" (p. 139). Dyrenfurth and Kozak's information literacy definition seemed to align better with technology literacy than information literacy. Finally, Leu and Kinzer (2000) defined technology literacy as "the ability to gather, organize, analyze, and report information using technology." Leu and Kinzer's technology literacy definition did use terminology that aligns with technology literacy, but it also aligned nicely with information literacy illustrating the interchangeability and alignment of the definition of these three constructs.

Definition Analysis Between Constructs

Analyzing the spectrum of definitions of each construct individually and collectively was difficult for many reasons. The first reason was the scope of the definitions. At one end of the spectrum was the philosophy of defining a construct such as technology literacy broadly ([ACRL] Association of College Research Libraries, ,, 2000; Doyle, 1992; Dugger, 1997; Hobbs, 2010; International Technology Education Association [ITEA], 2003; Leu & Kinzer, 2000; McMillan, 1996; Saedi, 2003; Shackelford et al., 2004; Tessmer, 1985; US Department of Education [DOE], 1996; Wonacott, 2001). At the other end of the spectrum was the philosophy that a construct needed to be defined with greater specificity (Colorado Department of Education, 2009; Dyrenfurth & Kozak, 1991; Fortier et al., 1998; Hague & Payton, 2011; Jones & Flannigan, 2006; Koning, 2001; Martin, 2005; Selfe, 1999). Virkus (2011) asserted that in addition to the spectrum of definitions, was that of perception. Perception of the definition as a whole, as well as how specific terms are perceived within the definition, was left to the reader and could differ from the intent of the author. An example of this was the use of the word 'ability' in the three constructs: digital, information and technology literacy. Ability was used 32 times, the second most frequently used word when all three constructs were analyzed collectively. The frequency in which ability was used in the three construct definitions illustrates the importance of the word in shaping the definitions. As defined in the Oxford English Dictionary (2017), ability is:

> Suitableness or adaptation for a purpose; fitness, aptitude; (also) an instance of this.

The quality in a person or thing which makes an action possible; suitable or sufficient power or proficiency; capability, capacity ***to*** do, or (now ***rare***) ***of*** doing something.

A natural faculty; a particular power of the body or mind; a personal talent or skill.

Providing definitions of ability helped with the understanding of ability. Ability is having the potential a person has to do something and should not be confused with skill - a person can do something.

A simple word frequency analysis was conducted using NVivo 11 Pro for Windows to better understand the construction of the digital, information and technology literacy definitions. A word frequency analysis helped identify the most frequently used words by analyzing the exact word, stemmed words, synonyms of the word, specializations of the words and generalizations of the word. For this analysis, the exact word grouping option was used to identify the top ten words that were used for each of the constructs as well as all three of them together. Table 5 is a list of the top ten most frequently used words in the definitions of digital, information, and technology literacy. Also, included in the list were the top ten words when the three constructs were analyzed collectively.

Table 5. Word frequency list for digital, information and technology literacy.

Digital (14)	Freq	Information (15)	Freq	Technology (14)	Freq	All Three (43)	Freq
digital	14	information	21	technology	13	information	34
ability	11	use	11	ability	11	ability	32
information	10	ability	10	use	9	use	29
use	9	evaluate	10	skills	7	technology	19
tools	7	needed	8	learning	5	evaluate	18
communicate	6	access	7	manage	5	digital	15
create	5	effectively	7	improve	4	skills	15
evaluate	5	locate	4	person	4	access	13
skills	5	recognize	4	assess	3	communicate	10
access	4	set	4	computers	3	effectively	10

Many of the definitions identified characteristics of what a person must possess to be digital, informational and technologically literate, and less emphasis was placed on required skills. Information tops the list of the most frequently used word when the three constructs were analyzed collectively. Many of the phrases that use information also include ‘use,' for example: ‘and use information,’ and ‘use of information in society.’ Other phrases that included ‘information’ were: ‘understand information,’ ‘exchange information,’ ‘create information,’ and ‘evaluate information.’ The use of ‘ability’ was the second most frequently used word and was typically within the first section of the definition. Typical phrases that contain ‘ability’ were: ‘ability of a,’ ‘ability to responsibly use,’ ‘ability to represent,’ with the most predominate phrase being ‘ability to use.’

In addition to a word frequency list in text form, NVivo also provided tools to graphically illustrate word frequencies in the form of a word cloud and a tag cloud. A word cloud (see Figure 2) assembles all the words associated with a specific word frequency list and assembled them in a 'cloud' of words. The most frequently used words are the largest, and are placed in the middle with the rest of the words radiating out by their frequency, decreasing in size with the decrease in usage.

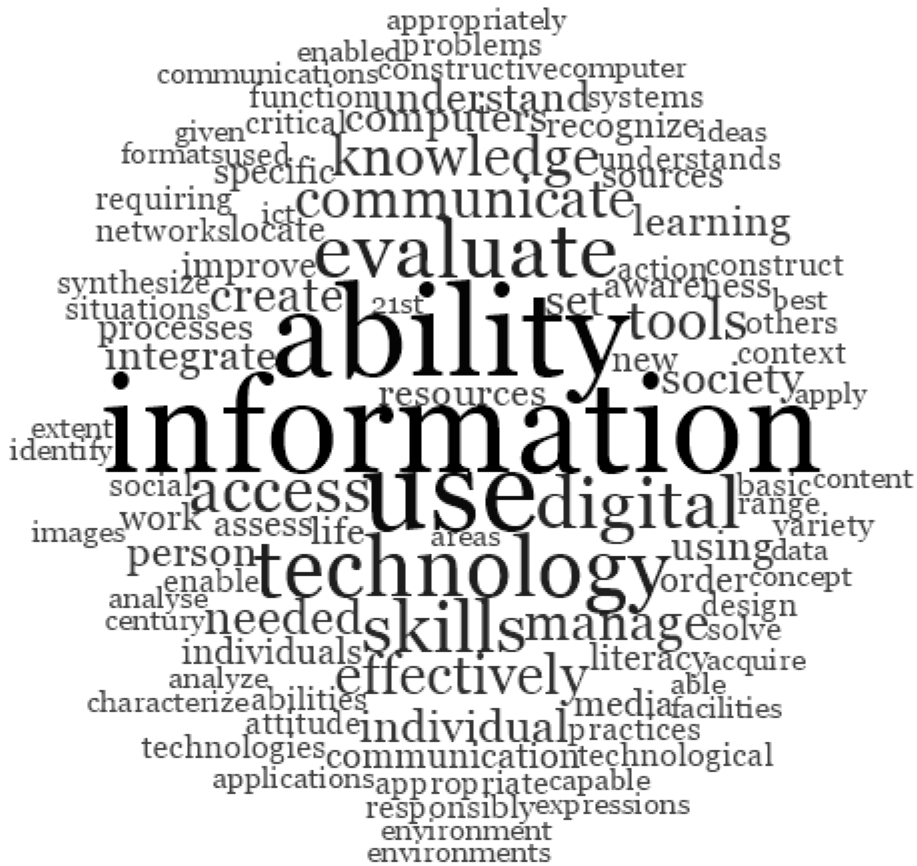

Figure 2. Word cloud of most frequently used word in digital, information and technology literacy definitions.

A word cloud was used more as a visual tool or aid than any form of analytical tool. Words become very congested the smaller they become. A tag cloud, on the other hand, could be used as more than just a visual aid. A tag cloud was similar to a typewritten document (see Figure 3) and was more common visually. Since most of what was written and read were in a linear form, it was easier to understand.

Figure 3. Tag cloud of most frequently used words in digital, information and technology literacy definitions.

All of the words from the All Three word frequency list were listed in alphabetical order, line by line. The more frequently the word was used, the larger the word was represented. An illustration like this could be useful for the construction of new definitions specifically created using the words that are most frequently used, hence being interpreted as the most important.

Earlier in this section, the rationale for reviewing digital, information and technology literacy definitions was explained – the interchangeability of the definitions. This interchangeability was clearly illustrated when reviewing the word frequently list (see Table 5) and was dissected individually to their elemental words. This was done to gain a better understanding of the key components of the definitions. For instance, the authors of the definitions for all three literacies felt that 'ability' was a very important key component in defining each of the constructs. As illustrated by the word frequency list of All Three constructs analyzed collectively (see Table 5), the result of the analysis focus was on ability (potential) and skills rather than characteristics.

Definition Analysis Within Technology Literacy Construct

Definitions help by explaining what words and phrase mean and what objects/things are in a clear and concise manner. Gaining a better understanding of the technology literacy construct, the definition of each word was looked at individually then as the technology literacy construct as defined by the International Technology Education Association (ITEA). ITEA defined technology as: "1) Human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. 2) The innovation, change, or modification of the natural environment to satisfy perceived human needs and wants" (International Technology Education Association [ITEA], 2000, p. 242). ITEA defined literacy as the "basic knowledge and abilities required to function adequately in one's immediate environment" (International Technology Education Association [ITEA], 2000, p. 239). ITEA had also defined the technology literacy construct as: "the ability to use, manage, assess, and understand technology" (International Technology Education Association [ITEA], 2000, p. 142). Analysis of each of the individual definitions of technology and literacy yielded that each included the words, knowledge, capabilities/abilities and environment. When each of the individual definitions was analyzed to the technological literacy definition, very few of the word associated with technology and literacy contributed to the definition of technological literacy.

The definition analysis within focused on the construct of technology literacy. The process for this analysis was to analyze the same 14 technology literacy definitions analyzed in the between analysis and the technology literacy definitions 20 states chose to adopt. As expected, when analyzing technology literacy definitions, the most frequently used word was technology. When analyzing the between constructs definitions, the greatest variance between word frequencies was 10 between 'use' and 'technology' when the three were analyzed collectively. When analyzing within constructs definitions, the greatest variance when analyzed collectively doubled to 20, between the most frequently used word 'technology' and second most frequently used word 'use.' This difference could be contributed to the word frequencies of the definitions the states created/adopted.

The definitions of technology literacy created/adopted by the states gave the impression of trying to be all-encompassing, which makes the definitions lengthy. Reviewing each of the four groups of definitions individually, the top 12 of the most frequently used words of the state technology literacy definitions were in double digits.

The definitions of information literacy came in second with the top four most frequently used words in double digits.

Table 6 is a list of the top 10 most frequently used words in the technology literacy definitions identified within the research and the created/adopted definitions used by the states because of the Enhancing Education Through Technology Act of 2001. Also, included in the list were the top 10 words when the two groups of definitions were analyzed collectively. This analysis was done by the researcher for this study.

Table 6. Word frequency list for technology literacy.

Technology (14)	Freq	State's (20)	Freq	Combined (34)	Freq
technology	13	technology	31	technology	44
ability	11	information	15	use	24
use	9	use	15	ability	23
skills	7	learning	14	learning	19
learning	5	literacy	13	information	18
manage	5	ability	12	literacy	15
improve	4	create	12	create	14
person	4	problems	11	skills	14
assess	3	solve	11	improve	13
computers	3	communicate	10	knowledge	13

When analyzing the All Three and Combined word frequency lists collectively, they were very similar with four of the top five most frequently used words being the same. To see how all four definition groups would look when analyzed collectively, a final word frequency analysis was conducted. Table 7 is the result of the final word frequency analysis.

Table 7. Word frequency list for technology literacy including State adopted definitions.

All Definitions	Freq
technology	50
information	49
ability	44
use	44
evaluate	27
access	22
skills	22
communicate	20
create	20

Skill and knowledge were two words that were believed to have significant roles in defining digital, information and technology literacy, but were used sporadically and less frequently than expected. Skill was used more consistently and more often than knowledge, but still only made a top five list within the technology literacy construct. Knowledge was used less frequently with the word only making the top ten list of the technology literacy group of definitions and the 20 created/adopted by the states. When all the definitions were analyzed collectively, skill and knowledge did not make the top ten most frequently used words within the constructs of digital, information and technology literacy.

The between construct word frequency was an analysis of definitions related to digital, information and technology literacy analyzed individually and collectively. Also analyzed was the within construct word frequency analysis of definitions related to technology literacy in the body of research as well as the definition used by 20 states. These analyses have shed light on the difficulty of defining these expansive constructs into a single encompassing definition. Because of this difficulty, this study looked at identifying exemplary technology literacy definitions, and not a single definition. With a list of exemplary technology literacy definition selected by experts, a definition can be selected to suit the situation. Another key objective of this study was to bring more focus on skills by creating an academic technology literacy assessment rubric.

Rubric Systems

Rubrics used for assessment provide users a easy to follow, visual and quick means of assessment. Many organizations like the International Society for Technology in Education (ISTE) and sub-organization the National Educational Technology Standards (NETS-S), North Central Regional Educational Laboratory (NCREL), National Research Council, International Technology and Engineering Educators Association (ITEEA) and the National Assessment of Educational Process (NAEP)/ Technology and Engineering Literacy (TEL) assessment program all have rubrics for assessment procedures and standards in place for assessing ones' technology literacy. The Association of American Colleges & Universities has developed the Valid Assessment of Learning in Undergraduate Education (VALUE) rubrics as part of their Liberal Education and America's Promise (LEAP) initiative (Association of American Colleges and Universities [AAC&U], 2016). However; these rubric systems have not been widely implemented beyond K-12 (Knight, 2006; Rosenblatt, 2010).

A rubric is a mechanism used for assessment. Rubrics fall into two primary types: holistic and analytic. A holistic rubric is where the assessment looks at the whole of a project while an analytic rubric looks at the specific performance of a standard at each level (J. Luft, 1997; Wiggins, 1998). A holistic rubric is either in rows or columns.

In rows, the criteria are to the left and the description to the right. In columns, the criteria are at the top, and the description is below (Waln, 2014). Analytic rubrics typically include both columns and rows in the form of a table or grid with criteria down the left side and heading along the top (Callison, 2000). Figure 4 is an example of an analytic rubric.

Student Skills Assessment Rubric

Employability Skills	Level 1 Novice	Level 2 Approaching Proficiency	Level 3 Demonstrates Proficiency	Level 4 Approaching Expertise/Leadership	Student Skill Level (1-4)
Information Literacy	Able to access information from familiar sources. Has difficulty organizing or evaluating information accessed.	Shows interest in learning how to access information from unfamiliar sources, and sometimes uses provided criteria to evaluate and organize information.	Usually able to locate, understand, organize, and evaluate information from familiar and unfamiliar sources using criteria most relevant to the task and setting.	Is frequently called on to explain to, or assist others in locating, understanding, organizing, or evaluating the quality and relevance of information from multiple sources.	
Technology Literacy	Uses familiar technologies in familiar ways. Little interest in learning new uses of familiar or new technologies.	Sometimes willing and able to learn new uses of familiar and new technologies, and shows interest in learning how to determine what is most appropriate.	Routinely uses, and learns new uses of, familiar and new technologies. Usually able to determine the most appropriate technology for a particular use without being told.	Teaches others how to use technologies and explains to others the criteria for judging the appropriateness of particular technologies for particular purposes.	
Initiative & Self-Direction	Completes assigned tasks with normal supervision if familiar, but requires constant supervision to complete unfamiliar tasks.	Will sometimes ask questions as needed to complete assigned tasks, and begins to self-monitor progress without constant supervision.	Routinely exhibits initiative and self-direction in completing assigned tasks, asking questions as needed, and keeps supervisor informed of progress.	Uses knowledge of self-motivation and self-regulation skills to motivate others and lead by example in completing assigned tasks.	
Professionalism & Ethics	Dresses and acts "professional" based on experience. May not take responsibility for mistakes or misconduct.	Makes visible efforts to imitate professional etiquette, standards, and ethics from professionals in the workplace. Takes responsibility for mistakes or misconduct.	Demonstrates professionalism in dress and behavior consistent with standards and workplace norms. Shows concern for professional ethics in addition to taking personal responsibility for mistakes and misconduct.	Is able to articulate and model the situational nature of some aspects of professionalism such as dress and etiquette, and the fundamental importance of standards and ethics.	
Adaptability & Flexibility	Comfortable switching among familiar behaviors or roles but uncomfortable with unfamiliar change in the environment.	Makes an effort to adapt to unfamiliar change in the environment and/or tries to be more flexible with encouragement and when the need is pointed out.	Usually adapts to changes in the environment without needing to be told, and is flexible in taking on different roles and responsibilities as required.	Notices changes in the environment that require adaptation or flexibility and helps others explore ways to adapt or be flexible to better achieve an intended outcome.	
Productivity & Accountability	Completes assigned tasks when the task is familiar and there are no unexpected obstacles. Has difficulty accepting constructive criticism.	Shows a beginning awareness of the importance of managing time, and persisting in the face of obstacles, to complete tasks. Accepts constructive criticism.	Routinely uses time-management skills to overcome obstacles and complete assigned tasks on time and to agreed-upon standards, requesting feedback on performance.	Helps co-workers manage time and overcome obstacles, and helps create shared sense of accountability among coworkers to supervisors and customers for delivering work on time and to agreed-upon standards.	

Figure 4. Example of a student skills assessment rubric.
Source:https://www.tn.gov/assets/entities/education/attachments/wbl_student_skills_assessment_rubric.pdf

Two literacy rubric systems have been used by institutions of higher education; they were the Rubric Assessment of Information Literacy Skills (RAILS) and the Valid Assessment of Learning in Undergraduate Education (VALUE) rubric system by the Association of American Colleges and Universities (AAC&U). RAILS was a three-year funded project looking at an information literacy assessment for higher education. The project was funded by the Institute for Museum and Library Services (Belanger, Zou, Mills, Holmes, & Oakleaf, 2015). The second literacy rubric system was also identified as information literacy. The information literacy VALUE rubric was disseminated by the Association of American Colleges and Universities (AAC&U). Institutions choosing to use the 16 VALUE rubric templates would adopt the rubric to their method of student learning assessment as it pertains to information literacy. AAC&U frames the rubrics use as:

> evaluating a collection of work, rather than a single work sample in order to fully gauge students' information skills. Ideally, a collection of work would contain a wide variety of different types of work and might include: research papers, editorials, speeches, grant proposals, marketing or business plans, PowerPoint presentations, posters, literature reviews, position papers, and argument critiques to name a few. In addition, a description of the assignments with the instructions that initiated the student work would be vital in providing the complete context for the work. Although a student's final work must stand on its own, evidence of a student's research and information gathering processes, such as a research journal/diary, could provide further demonstration of a student's information proficiency and for some criteria on this rubric would be required (Association of American Colleges and Universities [AAC&U], 2016).

The three areas of concentration for the VALUE rubric system were intellectual and practical skills (ten rubrics), personal and social responsibility (five rubrics) and integrative and applied learning with one rubric. Users of the VALUE rubric system consist of 12 VALUE leadership campuses and 135 VALUE partners (AAC&U, 2016).

One of the primary limitations of the RAILS and VALUE rubrics was that they do not address or provide a mechanism to assess skills. The structure of the RAILS rubric was on information literacy-focused broadly on competencies instead of specific skills with three topic areas of assessment: Determine Key Concepts, Access the Needed Information, and Retrieves Reverent Information. Competencies can incorporate skills and therefore seen as "more than the skill, they include abilities and behaviors, as well as the knowledge that is fundamental to the use of a skill" (Dubey, 2014). Skill, on the other hand, was "something learned in order to be able to carry out one or more job functions" (Dubey, 2014). The RAILS rubric system site was still active but has not been updated since the end of the funded project. The VALUE rubric was more comprehensive due to the number of rubrics; it was still broadly focused on competencies in areas such as creative thinking, quantitative literacy, information literacy, problem-solving, civic engagement, ethical reasoning, global learning, and integrative learning. These rubrics provided a mechanism for assessing abilities but did little to assess specific skills required within a course, especially related to technology literacy with a more focused view on basic academic technology literacy skills. Some of these skills were installing computer software and hardware, inserting an image into a document and clearing/deleting information from a cell.

Technology Literacy Self-Assessment Rubric

Today, in higher education, there are very few technology literacy rubric systems that offer students the ability to self-assess their technology literacy levels. Many of the rubric systems listed in a college catalog or on the college's website are used for information literacy assessment and not technology literacy.

Review of the literature for rubric systems was conducted solely using websites of higher education institutions. A Google search was conducted using Technology

Literacy Rubric and Technological Literacy Rubric as the search criteria. Websites with .edu were the primary search results reviewed. Some of the .edu websites had links to a .doc or .pdf of their method of technology literacy assessment. These documents were downloaded and evaluated for relevance.

Technology Literacy and Technology Literacy Rubric returned the same data but in a different order. Seventeen .edu websites were identified in the first five pages. After page five, the search results started to segment the search criteria into individual words, technology, literacy, rubric. At that point, it was determined that the point of saturation was met. Of the 17 sites, seven sites had enough information to review.

During the Google search process, many of the websites showed both information(al) and technology literacy as part of the results. James Madison University (JMU) listed technology literacy as part of the search, but the link connected to their general education site was Madison Research Essentials: Information Literacy (MREST) Competency @ JMU was explained or Madison Research Essential Skills Test (MREST). The site listed six information literacy competencies that students must acquire and pass the MREST skills test before the end of their first semester. This test was part of JMU's graduation requirement (James Madison University, 2017). There was no parallel requirement for technology literacy at James Madison.

Michigan Tech was similar to JMU in that as part of the search results information and technology literacy show in the results. The landing page for this link was a page for information literacy that was part of the library website. The website provides a holistic description of information literacy and provides a link to the AAC&U

VALUE rubric system as Michigan Tech was a VALUE partner. The Michigan Tech website also does not identify technology literacy, and an internal search using technology literacy as the parameters identified technology individually and not technology literacy (Michigan Tech, 2017).

Washburn University's Google search results not only listed both literacies but also referenced both literacies in their assessment documentation. On Washburn's site, information and technology were lumped into one definition. Washburn selected Project Standardized Assessment of Information Literacy Skills (SAILS) as their assessment tool for assessing information literacy and not information and technology literacy (Washburn University, 2017).

Montgomery College was misleading in their information referencing technology literacy. Information and technology literacy were referenced on their general education site, but number four of the general education competencies was technological competency and not technology literacy. As mentioned in an earlier section, competencies can incorporate skills and therefore seen as "more than the skill, they include abilities and behaviors, as well as the knowledge that is fundamental to the use of a skill" (Dubey, 2014), while technology literacy was more of an overarching construct. Number five of the GE competencies was information literacy. The misleading part was under the technological competencies section; the assessment tool was a technological literacy rubric. Clarity could have been achieved by matching the competency labels by naming number four technology literacy to match number five, information literacy (Montgomery College, 2017).

Wagner College provided a good example of working with information and technology literacy as one rubric. Wagner listed the two as co-curricular competencies. Wagner's framing language for the rubric goes the other direction of the other sites reviewed. Wagner puts a strong emphasis on technology and its use and little integration of information literacy considering the presented co-curricular nature. This rubric provided a good example of the need to have separation of the two literacies due to the different frameworks (Wagner College, 2017).

Estrella Mountain Community College was the only college website reviewed that had a dedicated webpage dedicated to technological literacy. The site defined technology literacy, list competencies and provided a guide for the incorporation of a technological literacy assessment into class assignments. Example of these competencies were data management and embedding objects. The webpage also provided many references related to assessment to aid faculty with incorporating assessment into their assignments (Estrella Mountain Community College, 2017).

The last two college websites reviewed each had an attribute of the proposed technology literacy rubric system. As part of the proposed ATLAS rubric, the faculty member would self-assess their courses for the level of technology literacy requirements for students to have to be successful in their course. Rowan College had ten core competencies, two of which are technological competency and information literacy. Similar to Montgomery College, Rowan listed technology literacy as technological competency but specifically defined each of them. As part of Rowan's syllabi structure, each syllabus had all ten core competencies listed as well as what competencies each task aligned with (see Figure 5) (Rowan College, 2017).

STUDENT LEARNING OUTCOMES: BUS 224 – SOCIAL MEDIA & INTERNET MARKETING

BUS 224 Students will:	**RCGC's Core Competency**	**Evaluation/Assessment:**
Demonstrate the use of commonly used Social Media/Internet Marketing tools such as Twitter, Facebook, YouTube, Email newsletters, Foursquare, Spotify, Linked In, blogs, and podcasts.	• Technological Competency • Information Literacy	Project Rubric
Explain the effects of Social Media on the way people work and live and the implications of Social Media for individuals and for the organizations.	• Global and Cultural Awareness	Exam Project Rubric
Create accounts and postings using Social Media tools.	• Technological Competency • Information Literacy	Exam Project Rubric

Figure 5. Skills rubric form syllabi used at Rowan College.
Source: Rowan College

Florida Gulf Coast University (FGCU) was the last website reviewed. FGCU offered students a web-based technology skills self-assessment tool (see Figure 6).

Basic Computer Operations and Concepts

	Yes	No	I don't know
Do you understand the basic function of computer hardware components such as the CPU, monitor, keyboard, and file storage?			
Can you find and start a program?			
Can you navigate between programs?			
Can you save files to the hard drive or removable storage, such as a CD or flash drive?			
Can you exit or quit an application?			
Can you log off a computer?			
Can you shut down a computer properly?			

Word Processing Skills

	Yes	No	I don't know
Can you create a new document?			
Can you save a document?			
Can you cut, copy and paste text?			

Figure 6. Example of a web-based technology skills self-assessment tool used by Florida Gulf Coast University.
Source: Florida Gulf Coast University

This self-assessment tool, in concept, was similar to the one being developed during this study. This example allows the student to identify, at the basic level – Yes or No, whether they believe they have the skill or not, not the level of their perceived skills (Florida Gulf Coast University, 2017). While the response categories in Figure 6 are not truly dichotomous because of the I do not know column; they could be considered dichotomous because it was presumed that most would answer yes or no. A dichotomous measure, in this case, may not be the best choice, while easy to score, they can be vague. For example, the first question under Basic Computer Operations and Concepts - Do you understand the basic function of computer hardware components such as the CPU, monitor, keyboard, and file storage were misleading. A student addressing this question might understand what a monitor or keyboard is but not the other two critical components. This student would probably select yes, which was not a true representation of the student's basic computer operations and concepts knowledge.

The websites reviewed all indicated they had some form of rubric system for self-assessment for technology literacy. For this study, a basic academic technology literacy rubric was created. Creating this rubric relied on experts in the field, asking them to align basic academic technology literacy skills with their respective skill levels. The method identified for this survey was the Delphi method, and more specifically, the modified Delphi method study.

Historical Development of Delphi Method

Collecting data from a narrow-focused sample requires the careful selection of the data collection methodology. The data collection methodology needs to be structured in a way to precisely collect data from a sample of Subject Matter Experts (SME); the Delphi Method study was identified as the best method for collecting data for this study. A Delphi method study is a "structured communication" (Linstone & Turoff, 1975, p.3). This structured communication typically consisting of three rounds of information gathering to build a consensus related to a topic (Norman, 1969). This type of research method utilizes both qualitative and quantitative methods (Gay et al., 2011).

Historians and some of the general population would not associate the word Delphi with a research method, but with ancient Greek history. Delphi is a town located on Mount Parnassus and was home to the 4th -Century-B.C Temple of Apollo. Pilgrims would bring offerings such as urns, money or a ritual statue buying them a turn to ask the oracle a single question of the future. These forecasts of the future were delivered to the pilgrims from the Oracle via Pythia, an intermediary woman. It was this forecasting that created the link between the Greek Delphi and the less mythical forecasting method created during World War II.

The Delphi Method was believed to have been developed in the 1950s by Olaf Helmer and Norman Dalkey, two employees of the RAND Corporation. Although Helmer and Dalkey were credited with the mechanics of the method, it was philosopher Abraham Kaplan that was credited with the naming of the method - Delphi. Dalkey did not like the name because of the connection to the Oracle of Delphi and its connotation of "something oracular, something smacking a little of the occult" (N. Dalkey, 1968, p. 8).

Because of its use during WWII, the true timeframe of the development of the Delphi method was somewhat unknown, but it was believed to have originated in 1944 (Gunaydin, 2006). The Delphi Technique/Method was developed as a means of forecasting the influence of technology on warfare (Custer et al., 1999; RAND, 2016). In a personal position paper written while employed by the RAND Corporation, Helmer (1967) provided a skeletal explanation of how the Delphi Technique/Method works in a report on forecasting the future. Helmer's position was that forecasting the future has become less of this unclear, fortune-telling attitude and more of a detailed sculpting of attitudes that can be shaped by collecting information from an expert, and this information, in turn, used to solve a specific problem.

Evolution and Validity of Delphi Method

Throughout the late 50s, 60s, and into the mid 70's, the Delphi method was categorized as an intuitive method used for technological forecasting (Arnfield & Schnittger, 1969; Bright, 1968; Cetron, 1969; Cetron & Ralph, 1971; N. Dalkey & Helmer, 1963; N. C. Dalkey, Brown, & Cochran, 1969; Helmer, 1967; Helmer & Rescher, 1959; Jantsch, 1967; Lanford, 1972; Martino, 1968; Sackman, 1974). Celtron (1969) defined technological forecasting as a "realistic estimate, by technically knowledgeable persons, of the rate, direction, and extent to which a particular technology or group of technologies will develop in a specific period of time" (p. 14).

During the late 60s, the Delphi method started to be seen as a stand-alone method and less of a part of technological forecasting. With this movement to a recognized stand-alone research method, it started to gain popularity outside the technological forecasting arena (Helmer-Hirschberg, 1966; Keeney, Hasson, & McKenna, 2001; McKenna, 1994). As the Delphi method started to gain in popularity outside the arena of technological forecasting, so did the criticism of the method as a sound empirical research methodology. One of the most cited criticisms of the Delphi methodology was written by Harold Sackman in 1974. The attack on the methodology of the Delphi was aggressive in and of itself, but what most scholars see as ironic was the Sackman's critique was written while he was at the RAND Corporation, the same company credited founders of the Delphi method worked for. Sackman (1974) evaluates the Delphi,

> against professional standards for social experimentation and for opinion questionnaires established by the American Psychological Association and other national professional organizations. Analysis of conventional Delphi indicates that it does not satisfactorily meet the numerous experimental and methodological standards cited for test design, item analysis, subject sampling, reliability, validity, administration, interpretation of findings and warranted social use (p. v)

Sackman concludes his critique with two additional bold statements that “the Delphi is an unreliable and scientifically invalidated technique in principle and probably in practice" (p. vi). The final statement was a recommendation that the “conventional Delphi be dropped from institutional, corporate, and government use until its principles, methods, and fundamental applications can be established experimentally as scientifically tenable” (p. vi).

To better understand the depth and breadth and provide validity, for the use of the Delphi method amongst the methodology critiques, a query search using Scopus was conducted using “Delphi Method” as the search keyword. Scopus was a peer-review literature abstract and citation database with over 21,500 titles and 60+ million records. All search filters were left at the default setting of All, setting the year filter as far back as indicated in the software, which was 1968. The analyzed results for the year, document type, and subject area have been tabularized (see Appendix E).

The Scopus identified 8,619 items with the keyword of Delphi method. The first Scopus analysis was the number of Delphi method studies conducted per year. In 1968-1969, nine references for Delphi method were identified and 123 during the date range of 1970-1979. The last ten-year date was from 2000 – 2009 with 2373 references for Delphi method were identified. The last full year analyzed was 2015 with 1003 references for

Delphi method were identified. The greatest increase was from 2012 to 2013 with an increase of 18.16%, and the smallest increase from year to year was from 2014 to 2015 with a 2.7% increase. Next, Scopus was used to analyze subject areas where the Delphi methodology was used. Articles (75.2%) and conference papers (14.1%) were the predominant document types (89.3%) for Delphi method scholarly activity. Health-related subjects hold three of the top ten subject areas with 5,407 or 62.7% of the subject areas that the Delphi method methodology was used. Of the remaining 37.3%, sciences were the predominate subject areas that the Delphi method methodology was used.

Contrary to Sackman's strong negative critique of the Delphi method, the methodology had consistently gained in number and breadth of scholarly activity in subject areas such as medicine, engineering, biochemistry, earth sciences, and neuroscience. According to Sackman, these subject areas would not use the Delphi method due to "the Delphi is an unreliable and scientifically invalidated technique in principle and probably in practice" (p. vi).

Consensus

The Nominal Group Technique (NGT), RAND Appropriateness Method (RAND) and the Delphi method are research methodologies that use consensus as a means of reaching agreement related to a particular topic. The NGT and RAND use as part of the consensus building formal, face-to-face meetings. The consensus was a ranked/prioritized list while the Delphi method does not typically meet face-to-face and consensus type and what constitutes consensus varies by the importance of the research topic (Campbell & Cantrill, 2001; von der Gracht, 2012). Keeney et al. (2006) pointed out that a Delphi study seeking a level of consensus on a critical issue might seek to set a 100% consensus level, whereas a Delphi study seeking consensus on the proper skills required for course outcomes might only seek a majority (51%) consensus. Table 8 illustrates von der Gracht's (2012) extensive literature review of 15 types of consensus methods used in Delphi studies emphasizes the diversity of consensus.

Table 8. Types of consensus methods used in Delphi studies.

Measure of Consensus	Criteria
Stipulated number of rounds	"Research indicated that three iterations are typically sufficient to identify points of consensus…Thus, three rounds were used in this study" (Fan & Cheng, 2006, p. 218).
Subjective analysis	The expert's rationale for a response had to be consistent with the mean group response (Mitchell, 1998).
	"Overall, it was felt that a third round of the study would not add to the understanding provided by the first two rounds and thus the study was concluded" (MacCarthy & Atthirawong, 2003, p. 800).
	"A consensus…was pursued through a series of personal interviews over several days." (Lunsford & Fussell, 1993, p. 15).

Table 8. Types of consensus methods used in Delphi studies. (continued)

Measure of Consensus	Criteria
Certain level of agreement	"In keeping with most other Delphi studies, consensus was defined as 51% agreement among respondents" (Loughlin & Moore, 1979, p. 103).
	"Consensus was achieved on an item if at least 60% of the respondents were in agreement and the composite score fell in the "agree" or "disagree" range" (on a 5 point Likert scale)"(Seagle & Iverson, 2002, p. 1).
	More than 67% agreement among experts on nominal scale (yes/no) was considered consensus (Alexandrov, Pullicino, Meslin, & Norris, 1996; Pasukeviciute & Roe, 2001).
	More than 80% on 5-Point Likert scale in the top 2 measures (desirable/highly desirable) was considered consensus (Putman, Spiegel, & Bruininks, 1995).
	Stewart et al. (1999) defined consensus as more than 95% agreement in the first Delphi round.
APMO Cut-off Rate (average percent of majority opinions)	Cottam et al. (2004) calculate an APMO Cut-off Rate of 69.7%, thus, questions having an agreement level below this rate have not reached consensus and are included in the next round.
	Islam et al. (2006) calculate APMO Cut-off Rates of 70% (first round) and 83% (second round) for consensus measurement.

Table 8. Types of consensus methods used in Delphi studies. (continued)

Measure of Consensus	Criteria
Mode, mean/median ratings and rankings, standard deviation	"In our case, mode was used as an enumeration of respondents who had given 75% or more probability for a particular event to happen. If this value was above 50% of the total respondents, then consensus was assumed" (Chakravarti, Vasanta, Krishnan, & Dubash, 1998, p. 159). Mean responses within acceptable range (mean ± 0.5) and with acceptable coefficient of variation (50% variation) were identified as opinion of firm consensus (Sharma, Nair, & Balasubramanian, 2003). Consensus was achieved, if ratings (4-point Likert scale) for the items fell within the range of mean ± 1.64 standard deviation. (Rogers & Lopez, 2002; West & Cannon, 1988). "An analysis of mean rank, percent of managers ranking a variable in the top 10, and standard deviation, indicated a sufficient level of consensus had been attained." (Doke & Swanson, 1995, p. 176).

Table 8. Types of consensus methods used in Delphi studies. (continued)

Measure of Consensus	Criteria
Interquartile range (IQR)	Consensus is reached when the IQR is no larger than 2 units on a 10-unit scale (Scheibe, Skutsch, & Schofer, 1975).
	Consensus was obtained, if the IQR was 1 or below on a 7-point Likert scale (De Vet, Brug, De Nooijer, Dijkstra, & De Vries, 2005).
	The respective consensus criterion was an IQR of 2 or less on a 9-point scale (von der Gracht & Darkow, 2010).
	IQR of 1 or less is found to be a suitable consensus indicator for 4- or 5-unit scales (Raskin, 1994; Rayens & Hahn, 2000).
	IQRs ranged from 0.00 (most agreement) to 3.00 (least agreement). Items with an IQR larger than 1.00 indicated a lack of consensus and were retained for the second interview (Hahn & Rayens, 1999; Raskin, 1994).
	Spinelli (1983) measured consensus in his study as more than a 1-point change in the interquartile range over three Delphi rounds.
	Ray and Sahu (1990) calculate the amount of convergence of group opinions by a formula using the interquartile ranges. A higher value of its outcome near to 1.0 indicates a higher degree of convergence.

Table 8. Types of consensus methods used in Delphi studies. (continued)

Measure of Consensus	Criteria
Coefficient of variation	The authors found the coefficient of variation at or below 0.5, which was to them a cut-off point conventionally accepted as indicating reasonable internal agreement (Zinn, Zalokowski, & Hunter, 2001). "A consistent decrease of the coefficients of variation between the first and the second round, indicated an increase in consensus (greater movement toward the mean)" (Buck, Gross, Hakim, & Weinblatt, 1993, p. 284).
Post-group consensus	"Post-group consensus concerns the extent to which individuals – after the Delphi process has been completed – individually agree with the final group aggregate, their own final round estimates, or the estimates of other panelists" (Rowe & Wright, 1999, p. 363); post-group consensus has been examined by Rohrbaugh (1979) as well as Erffmeyer and Lane (1984).

Table 8. Types of consensus methods used in Delphi studies. (continued)

Measure of consensus	Criteria
Stability	"A 'confidence' measure based on studies of observed probability of movement is then calculated. This takes the form of a 15 percent change level to represent a state of stability; that is, a change equal to or less than 15 percent between Delphi rounds means that stability has been achieved, and a change of more than 15 percent means that further Delphi rounds are required. The advantage of the stability approach is that it facilitates the extraction of extra information such as opinion distributions that attain a multimodal consensus." (Shields, Silcock, Donegan, & Bell, 1987, p. 182) "Stability refers to the consistency of responses between successive rounds of a study. It occurs when the responses obtained in two successive rounds are shown statistically to be not significantly different from each other, irrespective of whether a convergence of opinion occurs." (Dajani, Sincoff, & Talley, 1979, p. 84)

Certain level of agreement consensus method had been selected for this Delphi Method study. Specific consensus levels are defined in Chapter 3, Research Design and Rational Section.

Chapter Two Summary

The purpose of chapter two was to define the framework for this study. This was accomplished by providing the overview of the pragmatic paradigm and experiential knowledge theory. Life/learning, digital native/digital immigrant, and technophobic student demographics were also reviewed. Following this section was the literature related to the decades of definitions of digital, information and technology literacy and the vast number of definitions review. This review emphasized the need for a comprehensive universal definition of technology literacy. The current state of technology rubric systems that students can use for technology literacy self-assessment was reviewed. Lastly, a historical overview and the evolution/validation of the Delphi study was discussed.

CHAPTER THREE

METHODOLOGY

Introduction

The purpose of this modified Delphi method study was to identify exemplary technology literacy definitions from current technology literacy definitions and develop an Academic Technology Literacy ASsessment (ATLAS) rubric. For this study, a questionnaire was utilized to identify steps needed to implement the ATLAS at the course, department, college and university level. This rubric will allow students as well as faculty to self-assess and identify their technology literacy. The rubric will also provide a mechanism to identify what level technology literacy is required for any course and assess if they possess the requisite technology literacy skills needed to be successful in the course.

The beginning of chapter three revisits the purpose of the study and the research questions. Following the research questions was the rationale for using the Delphi method. The role the researcher holds in the research process and research validity have also be defined. In addition to these elements, the parameters of the study were explained starting with the research setting and population, the sample, participant selection and number, study development instruments, study instruments, data collection and analysis, study timeline, study outcomes, and summary.

This study used two instruments to develop the modified Delphi method study. First, a heuristic evaluation was used to reduce 25 technology literacy definitions down to ten to be used in the first part of the modified Delphi method study. Secondly, a pilot study of the modified Delphi method study was used to test the reliability and validity of the instrument before the modified Delphi method study was used. Table 9 provides an overview of this study.

Table 9. Research questions, study goals, Data Collection, and Outcomes.

Research Questions	Goal/Objective	Data Collection/Instrument	Outcome
RQ1: How do technology experts in higher education define technology literacy?	Bring forward a list of 10 exemplary technology literacy definitions reduced by technology experts from 25 technology literacy definitions identified in the literature.	Single Heuristic Evaluation reducing 25 technology literacy definitions to 10. These 10 definitions were included as part of the modified Delphi method study.	Exemplary technology literacy definition(s).
RQ2: How do technology experts in higher education align academic technology literacy skills with skill levels to create an Academic Technology Literacy ASsessment (ATLAS) rubric?	Develop an Academic Technology Literacy ASsessment (ATLAS) rubric.	Modified Delphi Method Study	An Academic Technology Literacy ASsessment (ATLAS) rubric.
RQ3: What steps would need to be taken to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, program, department, college and university level?	Identify the steps required to integrate the basic academic technology literacy rubric at the course, department, college and university level.	Integration Questionnaire	Procedures identified to integrate the basic academic technology literacy rubric at the course, department, college and university level.

Research Questions

The central research questions guiding this modified Delphi method study were used to gain a better understanding of the technology literacy construct. The questions were aimed at identifying exemplary definitions from current technology literacy definitions, create a basic academic technology literacy rubric, and identify steps needed to implement the rubric at the course, department, college and university level.

RQ1: How do technology experts in higher education define technology literacy?

RQ2: How do technology experts in higher education align academic technology literacy skills with skill levels to create an Academic Technology Literacy ASsessment (ATLAS) rubric?

RQ3: What steps would need to be taken to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, department, college and university level?

Research Design and Rationale

Pragmatic Paradigm

A pragmatic paradigm framework was used to shape this study. McCaslin (2008) defined pragmatic as "to locate practical and usable solutions to the stated problem" (p. 5). A pragmatic framework does not hold allegiance to a single research method and seeks multiple methods to find the solution to the problem. Creswell (2012) defined this approach as the collection and analysis of data using quantitative and qualitative research methods. Goldkuhl (2012) defined pragmatism as being "concerned with action and change and the interplay between knowledge and action" (p. 2). The action of this study would be the basic academic technology literacy rubric designed by consensus. This action would bring on the change of the addition of this rubric to course descriptions to aid students' self-assessment/identification of their technology literacy, something that did not exist. The interplay of knowledge and action was the student's and faculty's experiential knowledge.

At the center of a pragmatic paradigm was finding a solution to a problem. For this study, the problem was the lack of formal mechanisms to assist students in self-assessing their technology skills. As solutions, this study suggests a modified Delphi method study methodology which was ideally framed by the pragmatic paradigm because the paradigm was not bound to a certain research method or a single method. This study utilized qualitative and quantitative processes, which were indicative of a Delphi methods study.

Rationale

The Delphi method is an intuitive method used to solve problems (Lanford & Association, 1972). Solutions to the problems identified are facilitated by using a series of rounds of open and close-ended questionnaires and surveys to collect data from a panel of experts. Data are sequentially analyzed after each round by using both qualitative and quantitative methods to achieve a consensus solution to the problem (Okoli & Pawlowski, 2004).

The rationale for using the Delphi method research approach for this study was:

- Alignment with the Pragmatic paradigm of this study being problem-centered

- Does not require face-to-face meetings
- Employs open and close-ended data collection methods
- Participants are anonymous to each other
- Text and statistical methods were used during data analysis to determine consensus.

Classical Delphi Method

In chapter two, the historical development and evolution/validity of the Delphi Method/Technique were explained. The Delphi method in all forms, including the classical/traditional, is primarily a “structured communication” (Linstone & Turoff, 1975, p.3). This structured communication typically consists of three rounds of information gathering to build a consensus related to a topic (Norman, 1969). This type of research method utilizes both qualitative and quantitative methods (Gay et al., 2011). The first round typically employs an open-ended questionnaire that was qualitative (Hallowell & Gambatese, 2010; Murry & Hammons, 1995; Skulmoski et al., 2007). The next two rounds are structured and are created from information from each subsequent round and were more quantitative in design. This information was formulated into a Likert-scale survey to reduce and more concretely describe the information ultimately ending with a group consensus. In addition to themes, these last two rounds utilize quantitative methods, primarily descriptive statistics using means, and standard deviations or percentages to measure participant’s responses during rounds two and three (Kennedy, 2004; Skulmoski et al., 2007; Tapio, Paloniemi, Varho, & Vinnari, 2011).

Modified Delphi Method

This study will employ a modified Delphi method study. The modification to the classical/traditional Delphi method study was the changing of the method in which the round one survey questions were created. A modified Delphi method study was when one or more aspects of the traditional/classical had been modified such as a change in how rounds were formatted and conducted. A modification can also be how the survey was administered such as by conventional mail versus electronic mail (e-mail) (Custer et al., 1999). For this study, round one, question number two consisted of a survey with pre-defined items instead of an open-ended question. The primary reason for this type of modification was to increase the response rates (Custer et al., 1999). One of the limitations of any Delphi method study is the attrition of participants. This attrition is commonly attributed to a Delphi method study that will stretch over a long period of time. The attrition rate for this study was less as it was conducted within one semester and faculty members should remain constant during this period. Attrition is most commonly attributed to the length of time over which the research is conducted. The longer the term, the higher the attrition. Rates are subjective to the number of participants and the length of time, therefore, specific percentages of attrition are not identified within research (Day & Bobeva, 2005). Based on these arguments and rationale, the modified Delphi Method has been selected for this study. With any Delphi method study, from the classical to the modified Delphi method study, building consensus is the primary objective (Salancik, Wenger, & Helfer, 1971).

Consensus

Webster's New World College Dictionary (Agnes & Guralnik, 2006) defines consensus as “an opinion held by all or most, a general agreement” (p. 310). A certain level of agreement or simple percentage was a well-documented method of consensus. Consensus levels in the literature range from 51% to 80%, and some studies set consensus at 100% (Anderson, 2011; Chang, Gardner, Duffield, & Ramis, 2010; Cramer, Klasser, Epstein, & Sheps, 2008; De Villiers, De Villiers, & Kent, 2005; Hasson, Keeney, & McKenna, 2000; Heyman, 2010; C.-C. S. Hsu, Brian A, 2007; Last & Fulbrook, 2003; Loughlin & Moore, 1979; Murray, 1990; Slade, Dionne, Underwood, & Buchbinder, 2014; von der Gracht, 2012; Wegner, 2010; Williams & Webb, 1994). While most Delphi studies set a consensus level for all rounds, some studies use a varying level of consensus agreement for each level. De Villiers et al. (2005) study set a round one consensus level at 70%, a round two consensus level at 60% and a final, round three consensus level at 100%. To ensure the validity of the study results, Last and Fulbrook (2003) suggested setting the consensus level at 75% or greater. An 80% certain level of agreement was well established in the literature as a high-level of consensus in many Delphi Method studies (Conti, 2012; Cramer et al., 2008; Cuvar, 2015; Eubank et al., 2016; Green, Jones, Hughes, & Williams, 1999; Rea & Parker, 2014; Wu-Rorrer, 2015; J. A. Young, 2012). For this Delphi Method study, a certain level of agreement consensus method has been selected with an 80% certain level of agreement consensus being sought for both questions and each round.

Over the course of the three rounds of this modified Delphi method study, some adjustments were made to the level of consensus. The consensus cut-off level for this modified Delphi method study was set at 80%. During the analysis phase of round two, very few task/skills were reaching the high-level consensus cut-off value of 80%. For rounds two and three of this modified Delphi method study a change was made to the consensus level cut-off. Another accepted consensus cut-off level is a majority percentage (von der Gracht, 2012). Majority is defined as 51%, but for this modified Delphi method study the majority cut-off level was set at 60% due to the number of participants being 10. The change from an 80% consensus cut-off level to a majority (60%) consensus cut-off level increased the items added to the ATLAS from 29 for 80% to 65 for majority (60%) for rounds two and three.

Positionality and Reflexivity

A Delphi method study typically has components of a qualitative study as well as a quantitative study. Typically, the first round of a Delphi method study is qualitative, while the subsequent rounds are quantitative. For example, the first-round data collection often includes open-ended qualitative questions as a means of data collection. The subsequent round uses quantitative methods of data collection such as percentage, standard deviation, means and interquartile. Since the Delphi method study has a qualitative component; the researcher was an instrument within the research. Therefore, the researcher must address their position within the study as well as their self-reflection of their biases. As a Delphi method study was being designed and conducted, Linstone and Turoff (2002) suggest that a researcher was positioned within the study with power and influence, and has the potential to knowingly and unknowingly bias the study. Two key areas the researcher has influence over was the selection of the sample from the population and the creation of the instruments (Vernon, 2009).

Two processes that researchers typically use to keep biases at check are positionality and reflexivity. Positionality is an individual’s worldview (Foote & Bartell, 2011) that was shaped by personal characteristics such as age, race, gender, personal experiences, beliefs, values, biases and ideological theoretical and political positions (Berger, 2015). Berger (2015) presents three ways a researcher’s positionality can influence the research. First was the worldview and background of the researcher, and secondly, the lens the researcher chooses to use when asking questions as well as analyzing the results of the data. The researcher had a certain positionality with the participants when creating the questions, administering the questions and analyzing the results. This positionality can influence the findings. Berger (2015) suggested, for example, the researcher during the study identified with a participant more than other participants because of similar life-altering events. The second was shared personal characteristics such as age or gender. The research could be influenced because the researcher identifies with participants within the sample of similar age or gender, and maybe more willing to share information because of these similarities. Finally, the positionality of the research may be influenced by participants that are “perceived as sympathetic to their situation” (Berger, 2015, p. 220). These processes have shaped my understanding of the positionality I brought to this study.

To better understand positionality as a researcher within a study Herr and Anderson (2014) suggested asking the question, “Who am I in relation to my participants and my setting?” (p. 37). I started to address this question by explaining my technology literacy as it relates to higher education. I was positioned within this research with approximately 30 years of computer experience, 17 of which in higher education teaching a variety of courses that included a variety of non-degree specific and degree-specific software applications. Accompanying the depth and breadth of computer software knowledge was an equal number of years of computer hardware knowledge, which included the setup and operation of the typical equipment found in a computer lab as well as installation and repair of most PC based equipment. This technology literacy included computer peripherals such as standard and wide-format printers, projectors and LCD screens. This advanced level of technology literacy was coupled with 17 years as a tenured faculty member and 14 years as an administrator within the Montana University System, which was the setting, population, and source of the study sample. I was positioned within this study from conception to the final analysis and dissemination of the material. This intimate interaction with the study included all the preparatory work of introducing the study to readers, collecting and conducting an extensive literature review and selecting the appropriate research method to address the research questions. This position within the research also included the identification and selection of the sample cohort of participants for the heuristic evaluation, pilot study as well as the modified Delphi method study and integration questionnaire. I also was the primary author of the data collection instrument and well as conducted all data analysis of the heuristic evaluation, pilot study as well as the modified Delphi method study and integration questionnaire.

Reflexivity is when the "writer is conscious of their biases, values, and experiences" while conducting a qualitative study (Creswell, 2012, p. 216). Berger (2015) suggested that reflexivity was "the process of a continual internal dialogue and critical self-evaluation of researcher's positionality as well as active acknowledgment and explicit recognition that this position may affect the research process and outcome" (p. 220). I tried to address my reflexivity within this study by adopting a reflective journaling method. Krefting (1991) suggested reflective journaling should focus on three types of information: logistics of the study, methods describing decisions and the rationale behind them, and address personal reflections by writing about ideas, questions, concerns, and feelings that develop.

Research Setting and Population

A population, as it relates to research, was "the group to whom you wish to apply your results to" (Mertens, 2014, p. 4). The population the heuristic evaluation, pilot study, modified Delphi method study and integration questionnaire sample were selected from current and retired employees of the Montana University System (MUS). The Montana University System has 26 public and private institutions of higher education that offer completion/proficiency certificates to doctoral degrees. Included in the count of 26 institutions were seven tribal and three community colleges. This sample was selected from the TEACh committee for their knowledge of students' technology literacy levels and the technology literacy levels needed in a variety of academic settings.

To aid in the selection of participants, Adler and Ziglio (1996) suggested that participants should meet four requirements/criteria that aid in establishing them as experts: 1) Knowledge and experience with the issues under investigation; 2) Capacity and willingness to participate; 3) Sufficient time to participate; 4) Effective communication skills.

Sample

A sample is a selection from the population that is representative and is “ the group that you have chosen from your population from which to collect data” (Mertens, 2014, p. 4). This study utilized four different samples from the population described in the Research Setting and Population section. The four samples used for this study were; two developmental instruments - a heuristic evaluation and pilot study along with a modified Delphi method study and an integration questionnaire. The modified Delphi methods study and the integration questionnaire each needed their own samples separate from the samples already identified in the heuristic evaluation and pilot study. The heuristic evaluation and pilot study samples were described in detail in their respective sections under Development of the Modified Delphi Method Study. The sample, sample method and sample size for the modified Delphi method and the integration questionnaire were discussed in detail in the following sections. For this study, the terms sample and participants were used interchangeably. Table 10 provides an overview of the various data collection methods, samples, sampling methods, and sample numbers that were used in this study.

Table 10. Sample, Sampling Method and Sample Number

Data Collection Method	Sampling Method	*N*	Sample Cohort
Heuristic Evaluation	Snowball	3	from within higher education in the state of Montana with a strong technology knowledgebase
Pilot Study	Convenience	4	from the Teaching Excellence Action Committee (TEACh) located on the Montana State University campus
Modified Delphi Method Study	Purposive	10	a cohort of instructors teaching CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office during the spring 2018 semester
Integration Questionnaire	Purposive	4	an individual was selected from each of the four academic areas: course, department, college, and university

Development of the Modified Delphi Instrument

For this study, two instruments were used to develop the modified Delphi method study instrument: a single heuristic evaluation and a pilot study of the proposed modified Delphi method study. For the single heuristic evaluation, an expert panel was used to reduce 25 technology literacy definitions identified in the literature down to 10. These 10 definitions became question one of the modified Delphi method study instrument. This evaluation was done before the pilot study because the information from the evaluation provided information for the first question of the modified Delphi method pilot study and the main study. The second instrument used was a pilot study of the modified Delphi method study. The pilot study was used to test the validity and reliability of the modified Delphi method study instrument. The population and site selection for the heuristic evaluation and pilot study was selected from current and retired employees of the Montana University System (MUS). The population and site selection were the same as for the main modified Delphi method study, but the sample, sample method, sample size, data collection, and data analysis differ from the main modified Delphi method study. Because of this difference, the sample, sample method, sample size, data collection, and data analysis were covered in the heuristic evaluation and pilot study sections, respectively.

Heuristic Evaluation – Technology Literacy Definitions

This study used a single heuristic evaluation consisting of a panel of three experts from current and retired employees of the Montana University System (MUS) to reduce 25 definitions of technology literacy down to 10, which were included in the pilot study of the modified Delphi method study. I randomly selected 10 as the number to be respective of the evaluators time. Also, some of the definition's shared meaning and content. As explained later in this section, 10 was the maximum number; there is a chance the evaluators will not identify 10 following the criteria established for heuristic evaluations. Nielsen and Molich (1990) define a heuristic evaluation as "an informal method of usability analysis where some evaluators are presented with an interface design and asked to comment on it" (p. 249). Kölling and McKay (2016) identify a heuristic evaluation as "heuristic evaluation will allow us to … make reliable judgments about the usability and suitability of a tool" 2017 (p. 12:3). Each of these definitions of a heuristic evaluation could have been applied to the evaluation of technology literacy definitions. Nielsen and Molich (1990) definition replaced “an interface design” with “definitions of technology literacy” to read as an informal method of usability analysis where evaluators were presented with definitions of technology literacy and asked to comment on them. In Kölling and McKay (2016) definition, the words “a tool” would be replaced with “technology literacy definitions” to read as: heuristic evaluation will allow us to … make reliable judgments about usability and suitability of technology literacy definitions. Twenty-five differing technology literacy definitions have been identified and outlined in chapter two of this study and in Appendices A, B, C, and D. It was these 25 technology literacy definitions that were used for the heuristic evaluation.

The heuristic evaluation panel was presented with evaluation criteria and the 25 technology literacy definitions. The participant selection for the heuristic evaluation was obtained using snowball sampling. Snowball sampling is often employed when it becomes difficult to identify participants that meet specific criteria or knowledgebase. With snowball sampling, the researcher identifies an initial participant as meeting the researcher's criteria; then those participants identify additional participants until the sample number has been met (Gay et al., 2011). The criteria or knowledgebase the initial participate would possess a well-rounded understanding of technology, not just digital. This understanding of technology would be primarily grounded in the technology used in an academic setting at the higher education level. This understanding of technology would be coupled with at least 10 years of employment in the MUS. An email was sent to the initial individual(s) in the snowball sample asking for their participation and suggestions for additional participants meeting the criteria (see Appendix F for the email and Appendix G for the consent form). The panel was made up of three experts meeting the criteria of being from within higher education in the state of Montana with a strong technology knowledgebase reviewed the list of 25 definitions and reduced them down to a list of 10 definitions that were included in the pilot study of the modified Delphi method survey as well as the main modified Delphi method study. See Appendix H for the single heuristic evaluation instrument.

The panelists of the heuristic evaluation were asked to evaluate each of the technology literacy definitions using three heuristics as guides. The three heuristics were chosen from a larger list used for computer programming. From the list of the 13 heuristics, three have been selected. The three heuristics selected for this heuristic evaluation cross over without extensive altering, which would diminish the heuristic. Kölling and McKay (2016) identify 13 heuristics used for evaluations: engagement, non-threatening, minimal language redundancy, learner-appropriate abstractions, consistency, visibility, secondary notations, clarity, human-centric syntax, edit-order freedom, minimal viscosity, error avoidance and feedback (2016, pp. 12:7,12:8). Of the 13 heuristics, three were used for this heuristic evaluation:

> **Engagement:** The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest.
>
> **Minimal language redundancy:** The technology literacy definition should minimize redundancy in its language.
>
> **Human-centric syntax:** The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (Kölling & McKay, 2016, pp. 12:7,12:8)

The panelists evaluated each definition and scored each definition as to if it meets all three above mentioned heuristics. The definitions were scored per the following: if it meets all three heuristics (3 points), at least two heuristics (2 points), at least one heuristic (1 point), or none of the heuristics (0 points). For example, if a participant felt that a definition met all three heuristics, it received three points. The maximum a definition could score was nine. This was if all three participants felt the definition met all three heuristics. Results of the heuristic evaluation were sent to participants for feedback. Once the list of definitions had been identified and verified by participants, question one of the pilot study and main modified Delphi method study was created.

With the advent of computers and online electronic survey software such as SurveyMonkey and Qualtrics, the delivery of the survey and management of the data has become much more efficient than its pencil and paper predecessors. This heuristic evaluation was constructed and administered using Qualtrics. The heuristic evaluation included instructions as well as a timeline for completing the evaluation. The evaluation was housed on the Qualtrics website and could only be accessed by the researcher using a specific username and password. The participants for the single heuristic evaluation consisted of a panel of three SMEs selected using the snowball sampling method discussed in chapter three. Two of my colleagues were selected to provide names of participants that they felt would be able to meet the requirement of the single heuristic evaluation. The criteria for selection of the two initial participates was a well-rounded understanding of technology. This understanding of technology was primarily grounded in the technology used in an academic setting at the higher education level. An email was sent to the initial two individuals in the snowball sample asking for their participation and suggestions for additional participants. Of the two initial participants selected, one chose to participate, and supplied one name, while the other declined to participate, but provided three names. Emails were sent to the four potential participants that were identified. Of the five identified as possible participants, one did not respond to any emails., while four responded agreeing to participate. Of the four, three completed the single heuristic evaluation. The participants were emailed a link to access the heuristic evaluation. The single heuristic evaluation and informed consent forms were individually sent to the four that agreed to participate with a completion date set for seven days later. A reminder email was sent to all four participants on the fourth day of the survey. Three of the four participants completed the survey. The single heuristic evaluation was closed on the seventh day of the survey. The results of the study and a thank you for their participation was emailed to the three participants individually. Once all responses had been returned by the panelists, my analysis of the data began and consisted of reviewing the results for scoring and redundancies such as duplicate responses, missing data, and skipped definition evaluations. The outcome of the single heuristic evaluation was a list of technology literacy definitions identified by the evaluation. The results of this heuristic evaluation were part of the modified Delphi method study to identify exemplary technology literacy definitions.

Pilot Study – Modified Delphi Method

A pilot study is a small-scale representation of a full-scale qualitative or quantitative study that is conducted over a shorter timeframe (Gay et al., 2011). The primary purpose of the pilot study was to test for instrument validity and reliability. Validity is the degree to which an instrument measures what it is expected to measure, more specifically, face and content validity. Face validity "is the extent to which, on the surface, an instrument looks like it is measuring a particular characteristic" (P. Leedy & Ormrod, 2010, p. 92). For example, if a survey/questionnaire is looking to answer certain items related to the construct of cognitive apprenticeship, there should be no questions about economics. Face validity also addresses how the instrument looks. Parsian and Dunning (2009) have identified three items to determine the face validity of an instrument:

- The clarity of the wording,
- The likelihood the target audience would be able to answer the question,
- The layout and style (p. 3).

Associated with face validity is content validity. Content validity "is the extent to which a measurement instrument is a representative sample of the content area (domain) being measured (P. Leedy & Ormrod, 2010, p. 92). Mokkink et al. (2010) created the COSMIN checklists (COnsensusbased Standards for the selection of health status Measurement Instruments) to evaluate quality and measurement properties. The COSMIN checklists consist of 10 checklists including four validity checklists, one of which is for content and face validity. The content and face validity checklist contain five items:

- Was there an assessment of whether all items refer to relevant aspects of the construct to be measured?

- Was there an assessment of whether all items are relevant for the study population? (e.g. age, gender, disease characteristics, country, setting)
- Was there an assessment of whether all items are relevant for the purpose of the measurement instrument? (discriminative, evaluative, and/or predictive)
- Was there an assessment of whether all items together comprehensively reflect the construct to be measured?
- Were there any important flaws in the design or methods of the study?

In addition to the COSMIN checklists, the Hadassah Medical Center has created a checklist for the development and validation of instruments. This checklist consists of 17 items (see Appendix I) that could be arranged in a dichotomous instrument for validating instruments (Hadassah Medical Center, 2017). Yu (2005) suggested that since face validity was subjective, the validation of the instrument can be done by an individual, while on the other hand, content validity was checked by a group of content experts.

A counterpart to validity was reliability. Reliability is the consistency in which an instrument repeatedly reports back the same results each time (P. D. Leedy & Ormrod, 2005). Validity and reliability are covered in more depth later in this chapter.

Other reasons to utilize a pilot study are to work out any issues and concerns with sample selection, instrument design and implementation, data collection methods and mechanics and data analysis methods (Schreiber, 2008). The pilot study might identify that the participant selection is not appropriate in size and knowledge of the topics being studied. A pilot study also provides an opportunity for the researcher to implement an untested data collection instrument. An untested instrument may have readability and usability issues that will come to the forefront. Some of these issues may be inaccurate or incomplete instructions, mislabeled and incomplete sections and artifacts from another instrument used as a starting point. A pilot study can also identify issues and concerns with software used to create, distribute the survey and analyze the data. The software may not return the appropriate or unusable data or might not return the data at all.

The sample participants, selection, and number for this pilot study consist of four participants that were selected using convenience sampling from the Teaching Excellence Action Committee (TEACh) located on the Montana State University campus to pilot the instrument for face and content validity and reliability. Convenience sampling is when a sample is selected from volunteers willing to participate in the study (Gay et al., 2011). The TEACh committee consisted of a member from each academic college, one undergraduate and graduate student and a representative from the Library for a total membership of 14. All members of the TEACh committee have at least an intermediate technology literacy level, many of them are well versed in technology literacy, especially within their area of expertise. The knowledge of their technology literacy was informally assessed during numerous committee meetings and interactions. The TEACh committee as involved in identifying, and in conjunction with the Center for Faculty Excellence, offering workshops and allocating funds for faculty development. Many of the members of the TEACh committee were knowledgeable in research methodologies and understood the importance of this step in the research process. The participants for this pilot study were selected using convenience sampling from the Teaching Excellence Action Committee (TEACh) located on the Montana State University campus to pilot the instrument for face and content validity and reliability. During a spring 2018 TEACh meeting, a verbal invitation to participate in the pilot study for the modified Delphi method study was announced with an explanation of the study and their involvement as participants would involve. Of the 12 members in attendance, five agreed to participate in the pilot study for the modified Delphi method study. Of the five participants, four completed the pilot study. An email was sent out to the committee members that have agreed to participate in the pilot study outlining the study and the instructions for the pilot study.

Participants of the pilot study were provided an overview of the pilot study explaining the instrument and the sample for the modified Delphi method study. The pilot study consisted of four areas, the first area, the informed consent section consisting of five questions (see Table 11). The five questions asked participants if they understood that their participation was voluntary, and they may withdraw at any time, their information would remain confidential, there are no anticipated risks, they may contact the researcher at any time and that there may or may not be any compensation for their participation. The second area was the demographics section, the third area was the technology literacy definition area, and the last section was the modified Delphi method study.

Table 11. Informed Consent – Pilot Study

Informed Consent	Yes	No	%
I understand that my participation in this study is voluntary and I may withdraw from this study at any time without consequences.	4	0	100%
I understand that any personal information collected during this study will remain confidential, secure on a password protected computer/locked in a secure cabinet for the duration of this study, and five years beyond, which at this time it will be destroyed.	4	0	100%
I understand that there are no anticipated risks in participating in this study.	4	0	100%
I understand that I may contact the researcher at any time to ask questions regarding this study.	4	0	100%
I understand there are no direct benefits to me or compensation for participating in this study.	4	0	100%

The last section contained questions related to validity, reliability and any additional comments. The implementation of the pilot study was administered via an online survey software called Qualtrics. Qualtrics was utilized for survey creation, implementation, data collection, data analysis, and data storage. Participants were asked to respond and return the survey within seven days. A reminder was sent out four days from the date the original survey was sent via email. Once all responses had been returned, analysis of the data began. The end of the survey consisted of assessment questions that pilot study participants filled out providing additional survey assessments. These questions were related to overall readability and usability. Information from this study was reviewed and incorporated into the modified Delphi method study.

Analysis of the data consisted of reviewing comments from participants regarding the overall readability and usability of the instrument as well as the areas that needed adjustment before the modified Delphi method study was administered. The outcome sought at the end of the pilot study was an instrument that was valid and reliable in measuring what the instrument it was expected to measure, reliably.

Modified Delphi Method Study

Sample

Participants in a modified Delphi method study are often referred to as a panel signifying the collective whole and panelists signifying the individual. A panel is typically comprised of Subject Matter Experts (SMEs) within the field and the topic being studied (N. Dalkey & Helmer, 1963). A critical aspect that differed from other forms of research methods was the participants did not need to be representative of the population (Okoli & Pawlowski, 2004). The participant sample identified for this modified Delphi method study was not dependent on a particular demographic, gender, educational level or Social Economic Status (SES). Participants for this modified Delphi method study were selected because of their knowledge of technology and technology literacy, their knowledge of students' technology literacy levels and the technology literacy levels needed in a variety of academic settings.

Twenty-nine individuals were personally invited to participate via email were from 13 public and tribal institutions of higher education in Montana. No individuals were identified from the private institutions of higher education in Montana. Invitation emails were individually sent to the 29 individuals teaching CAPP 120 - Introduction to

Computers and CAPP 131 – Microsoft Office during the 2017-2018 academic year (see Appendix J). The Montana University System has designated CAPP 120 and CAPP 131 as common courses within the university system requiring instructors to utilize the same textbook. In addition to teaching from the same textbook, instructors teaching CAPP 120 and CAPP 131 must also ensure that at least 80% of the material being covered matches that being taught at other institutions offering CAPP 120 and CAPP 131.

As part of the email, it was explained that for participation in all three round modified Delphi method study was incentivized with a $50.00 electronic Amazon gift card. Of the 29, 12 agreed to participate in the modified Delphi method study. Of the twelve participants that agreed to participate, 10 completed all three rounds and received the incentive. Two instructors that agreed to participate opted out before starting round one.

Sample Methods and Size

Selecting a sample for a Delphi study utilizes nonrandom sampling techniques such as convenience, purposive (judgment), quota and snowball sampling (Du Plessis & Human, 2007). The Participant selection for this study was selected using purposive sampling. Purposive sampling is where the researcher uses their expertise to identify characteristics of the sample and selects participants based on their knowledge and experience meets up with the construct being studied (B. Johnson & Christensen, 2012).

The purposive sampling for the modified Delphi method study was selected from a cohort of instructors on record for CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office courses offered at institutions of higher education in the state of

Montana. This course was selected because 80% of the material taught across the MUS was the same and was considered non-degree specific basic academic technology literacy skills. These non-degree specific basic academic technology literacy skills were skills such as basic computer operation, communication, word processing, spreadsheet and presentation skills. Only one instructor was selected from institutions with more than one section of CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office; this was done to preserve anonymity.

The number and selection of participants for Delphi method studies vary greatly. A study conducted by Skulmoski, Hartman & Krahn (2007) looked at Delphi study sample sizes as one aspect of published research, theses, and dissertations. The sample sizes for the 30 research publications reviewed ranged from three participants to 171 with the average participants being 37.53. The sample sizes for the 41 theses and dissertations review ranged from eight to 345 with the average being 43.24 participants.

Participant retention was one of the primary concerns of Delphi method studies. Dropout rates are greatest when the duration of the study is over an extended timeframe. An empirical study conducted by Polland and Pollard (2004) had a reduction of participants from a total of 63 participants initially identified to only 30 that were able to complete the three rounds typical of a Delphi study. Ten to 15 participants was a sufficient number to achieve consensus (Delbecq, Van de Ven, & Gustafson, 1975; Okoli & Pawlowski, 2004). For this study, 10 participants were selected and retained for the duration of the three rounds.

Instrument

Instruments used in a Delphi method study typically consist of open and close-ended questionnaires and Likert scale surveys. A questionnaire is an instrument that collects data for non-statistical analysis while a survey is an instrument that collects data for statistical analysis (McKee, 2015). The questionnaire was typically open-ended and was used during the first round to collect information. This study will utilize a survey as well as a questionnaire. The survey that was utilized in this study was to address research questions one and two as part of the modified Delphi method study. The data from the first round of the modified Delphi method study was used to create the round two survey. Round two responses were used to formulate the survey for round three. Delphi method studies typically end after the third round. Analysis of the data was conducted after each round, which in turn was used to formulate the subsequent rounds. The questionnaire that was utilized in the study will address research question three.

As mentioned earlier in this chapter, a critical limitation of a typical Delphi method study was the attrition of participants. Attrition is commonly attributed to a Delphi method studies being stretched over long periods of time. Priorities of the participants over extended periods of time typically change requiring participants to drop out of the study. This attrition of participants may drop the sample size below the desired level. The primary reason for using a pre-defined list was to improve response rates (Custer et al., 1999). Custer et al. suggest the pre-defined items be selected from sources such as reviews of the literature and evaluations of the items by experts.

For this modified Delphi method study, the items for the survey consisted of information from the heuristic evaluation for question one. There are two objectives for the modified Delphi method study that correspond to research questions one and two. The first section of the survey addressed the 10 definitions identified in the single heuristic evaluation and validated in the pilot study. Participants in the modified Delphi method study were asked to evaluate the definitions based on the three heuristics, engagement, minimal language redundancy and human-centric syntax. The second part of the survey addressed technology literacy skills from information from empirical research studies of technology literacy skills conducted by Christina Smith (2015) and a defined list of skills listed in Office 2016 Simplified (Marmel, 2016). Smith's (2015) research identified technology literacy skills that graduates perceived as being critical while a student and at work. This body of research provided a foundational list of skills that have met an 80% consensus level within her study. Marmel's (2016) book on Office 2016 Simplified was the most extensive book specifically listing how to learn specific skills such as setting margins, spreadsheet cell formulas and applying a master slide style to all slides in a slideshow.

Participants that agreed to participate in this study were sent an email outlining the modified Delphi method study and process as well as a consent form for them to sign and return. A URL link was included in the email to all the participants linking them to the survey. The identity of the participants of the modified Delphi method study was known only to the researcher, and at no time during the modified Delphi method study was there be any face-to-face meetings or correspondence between participants. The anonymity of participants was one of the strengths of the Delphi method (Delbecq et al., 1975). Participants were asked to respond and return the survey within seven days. A reminder was sent out four days from the date of sending the original survey via email as well as the morning of the seventh, and final day. Qualtrics was used to administer the surveys to all participants during all three rounds. This process was followed for each round of the modified Delphi method study.

Round One. The round one consisted of two questions that were formatted in a Likert scale structure. The first question asked participants to identify exemplary technology literacy definition. In the second question participants were asked to pair basic academic technology literacy skills in computers, word processing, spreadsheet, Database, presentation, and email/communication skills with the appropriate Dreyfus Skill Acquisition level: novice, advanced beginner, competent, proficient and expert skill levels. Figure 7 is a sample from the survey that was used as part of this study (see Appendix for the complete survey).

Word Processing Skills

	Novice	Advanced Beginner	Competent	Proficient	Expert
Create a new document	○	○	○	○	○
Opening an exisiting document	○	○	○	○	○
Add image to document	○	○	○	○	○
Formatting text	○	○	○	○	○
Copy & Paste	○	○	○	○	○
Set tabs	○	○	○	○	○

Figure 7. Sample from the survey that was used as part of this study.

It was understood that most participants would be versed in the use of Microsoft Office suite of software, but some of the participants might use a word processing software other than Word, or a spreadsheet software other than Excel. This understanding is why [word processing] was used instead of [Word].

The column headings (novice, advanced beginner, competent, proficient and expert) were derived from the Five-Stage Model of Adult Skill Acquisition (Dreyfus & Dreyfus, 1980). The Dreyfus's Five-Stage Model of Adult Skill Acquisition framework was an established model for assessing the steps for skill acquisition and provides the rubric skill level framework. Dreyfus & Dreyfus indicates that the acquisition of skills begins at the novice level and progresses to the expert level incrementally. The five stages of Adult Skill Acquisition are:

Novice: Needs continual direction and instruction to complete the task. Has an elementary understanding of the task.

Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.

Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.

Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.

Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level. (Dreyfus & Dreyfus, 1980)

Figure 8 illustrates the complete process for round one of the modified Delphi method study. The first step was to design the data collection instrument. The second step was to use this instrument to collect the data from the identified sample. The third step was to analyze the data by the methods identified. The fourth step was to provide feedback to the sample regarding the results of the round.

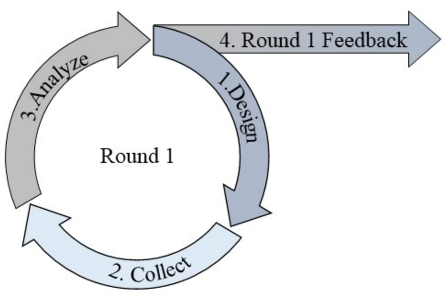

Figure 8. Complete iterative process for round one of the modified Delphi method study.

Round Two. Round two will follow the same structure of round one consisting of two questions that were formatted in a Likert scale structure. The first question asked participants to identify exemplary technology literacy definition. During my analysis, definitions that did not met the minimum consensus level of 80% were not included in the round two instrument and were not added to a list of exemplary technology literacy definitions. In the second question, participants were asked to rate the remaining (79% and below) technology literacy definition that did not meet the 80% minimum consensus level. The survey consisted of the technology literacy definitions and basic academic technology literacy skills that did not meet the consensus cutoff. During my analysis, responses that meet the 80% consensus value were added to the exemplary technology literacy definition list and basic academic technology literacy rubric. Items that did not meet consensus were compiled and formatted for round three after feedback from participants was reviewed.

Figure 9 illustrates the iterative process, which is the “a systematic, repetitive, and recursive process in qualitative data analysis. An iterative approach involves a sequence of tasks carried out, in the same manner, each time and executed multiple times” (Mills, Durepos, & Wiebe, 2010). Feedback from Round one influenced the design of the instrument to be used in round two. This iterative process was 1.) Design of instrument, 2.) Collect the data, 3.) Analyze the data, and 4.) Feedback of the current round was sent to participants for review.

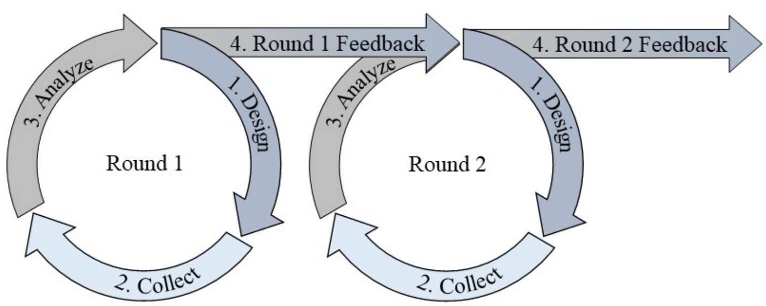

Figure 9. Complete iterative process for round two of the modified Delphi method study.

Round Three. Round three followed the same structure of round two consisting of two questions that will be formatted in a Likert scale structure. The first question contained the remaining technology literacy definitions that did not achieve an 80% consensus. Participants identified any remaining technology literacy definition they felt were exemplary, which may not yield any new exemplary definitions. Definitions not meeting the 80% consensus level during round three were dropped from consideration. Question two, round three of the modified Delphi method study also contained all of the remaining skills that had not been paired with a skill level. Similar to the technology literacy definitions, participants identified any remaining skills and pair them with the appropriate skill level. Skills/skill levels that did not meet the 80% consensus level during round three was dropped from consideration. Figure 10 illustrates the complete modified Delphi method study through the three iterative rounds of design, collect, analyze, and feedback.

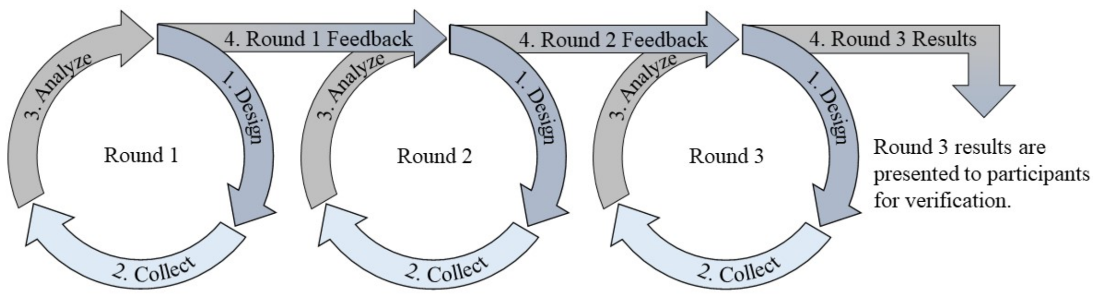

Figure 10. Complete modified Delphi method study through three iterative rounds of design, collect, analyze, and feedback.

Figure 11 represents the modified Delphi method study in a graphical form, connecting the research questions and data collection and analysis methods. Figure 11 also illustrates the sequential process of each of the data collection instruments starting with the single heuristic evaluation. The single heuristic evaluation needed to be completed before the pilot study, pilot study before the modified Delphi method study, and the modified Delphi method study before the integration questionnaire. The following steps outline the sequential data collection and analysis process illustrated in Figure 11.

1. Single heuristic evaluation – Reduced 25 technology literacy definitions down to 10.
2. Ten technology literacy definitions became question one of the pilot study and modified Delphi method study.
   a. Question one – addresses research question one.
   b. Question two – address research question two.
3. Pilot test modified Delphi method study
   a. Address comments from the pilot study of modified Delphi method study.
4. Administered modified Delphi method study – Round one.
5. Analyzed round one responses.
   a. Responses that meet the minimum 80% consensus level.
      i. Populate list of Exemplary technology literacy definitions.
      ii. Populate basic academic technology literacy rubric.
   b. Responses that do not meet the 80% consensus level are used in questions one and two of modified Delphi method study - round two.
   c. Analysis of round one sent to participants for feedback – create round two survey.
6. Administered modified Delphi method study – Round two.
7. Analyzed round two responses.
   a. Responses that meet the majority consensus level.
      i. Populate list of Exemplary technology literacy definitions.
      ii. Populate basic academic technology literacy rubric.

b. Responses that did not meet the majority consensus level are used in questions one and two of modified Delphi method study - round three.

c. Analysis of round two sent to participants for feedback – create round three survey.

8. Administered modified Delphi method study – Round three.

9. Analyzed round three responses.

    a. Responses that meet the majority consensus level.

        i. Populate final list of Exemplary technology literacy definitions.

        ii. Populate final basic academic technology literacy rubric.

    b. Responses that did not meet the majority consensus level will no longer be considered.

    c. Final analysis sent to participants for feedback – created final lists of exemplary technology literacy definitions and created final basic academic technology literacy rubric.

10. Outcomes of study

    a. Exemplary technology literacy definitions.

    b. Basic academic technology literacy rubric.

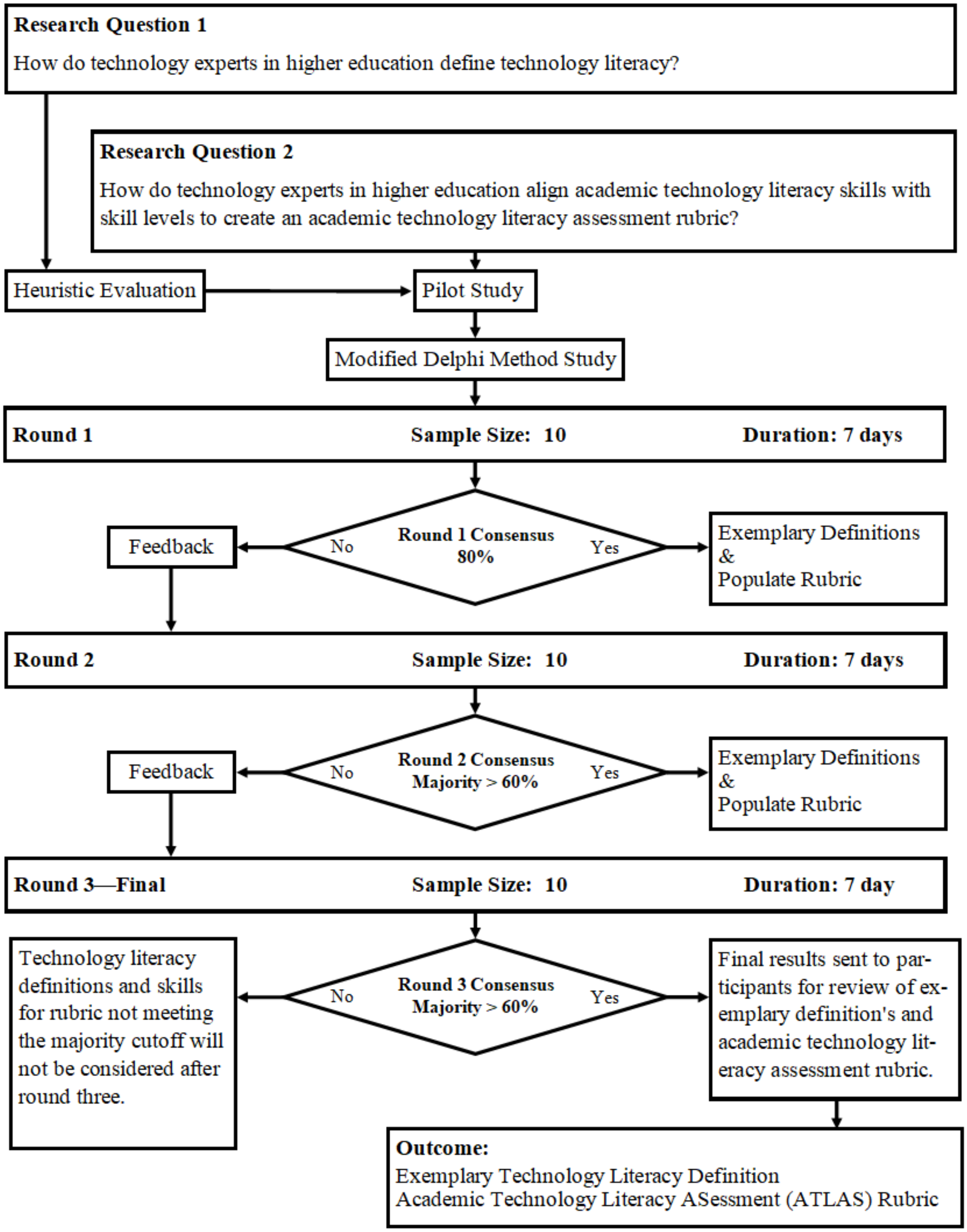

Figure 11. Graphical illustration of the sequential process of the data collection instruments starting with the single heuristic evaluation.

Data Collection and Analysis

Data collection for a Delphi study is a systematic, sequential and structured method of gathering data from a panel of experts over a number of rounds providing controlled feedback leading to a consensus/agreement among participants that did not exist prior (Keeney, Hasson, & McKenna, 2011).

The implementation and data collection of the survey was via the internet/ World Wide Web (WWW) utilizing an electronic survey software called Qualtrics. Qualtrics was utilized for survey creation, implementation, data collection, data analysis, and storage. The survey data for each round was housed on the Qualtrics server and was retrieved from the Qualtrics server and analyzed after each round. The link to the Qualtrics modified Delphi method study and integrated informed consent form were individually sent to 12 CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office SME instructors that agreed to participate with a completion date set for seven days later (see Appendix K for the modified Delphi method study instrument). Due to many of the colleges were either coming off spring break, on spring break or going on spring break, the modified Delphi method study round one deadline was extended. A reminder email was sent to all 12 SME participants on day four. A second reminder was sent out on day six. Ten of the 12 SME participants completed round one. The modified Delphi method study round one was closed and the results of the modified Delphi method study round one were emailed to the 10 participants. The informed consent information from the participants is contained in Table 12.

Table 12. Modified Delphi Method Study – Round One

Informed Consent	Yes	No	%
I understand that my participation in this study is voluntary and I may withdraw from this study at any time without consequences.	10	0	100%
I understand that any personal information collected during this study will remain confidential, secure on a password protected computer/locked in a secure cabinet for the duration of this study, and five years beyond, which at this time it will be destroyed.	10	0	100%
I understand that there are no anticipated risks in participating in this study.	10	0	100%
I understand that I may contact the researcher at any time to ask questions regarding this study.	10	0	100%
I understand there are no direct benefits to me or compensation for participating in this study.	10	0	100%

All 10 of the SME participants identified that they understood that their participation was voluntary, and they may withdraw at any time. All 10 of the SME participants understood that the information they provided would remain confidential and that there were no anticipated risks with the modified Delphi method study. All 10 of the SME participants understood that might contact the researcher at any time and that there may or may not be any compensation for their participation. For the modified Delphi method study, a $50.00 electronic gift card was awarded to all of the SME participants that completed all three rounds of the modified Delphi method study. All 10 SME participants completed all three rounds. For rounds two and three, each of the SME participants was issued a unique three-letter identifier. Random.org was used to generate the unique three-letter identifiers. Each SME participant was emailed their unique three-letter identifier along with the Qualtrics link to round two of the modified Delphi method study. As part of the modified Delphi method study, each SME participant was asked to provide their unique three-letter identifier.

Once round one responses were analyzed, and the rubric sent to participants for review and feedback, round two survey of the skills that did not meet consensus was designed. The round two survey was also administered using Qualtrics. The process for round two was the same process as for round one. Once the results for round two were returned they were analyzed using descriptive statistics to see what responses achieved consensus. All items that reached the consensus threshold were added to a list of exemplary technology literacy definitions and the ATLAS rubric. Any individual items that did not reach consensus were formatted for use in the round three survey. Once the rubric was populated with the non-consensus items, the rubric was sent to the participants for review and feedback. Following round three, a final rubric with all the items that met the consensus threshold was distributed to the participants verifying the consensus for each of the areas in the rubric. Technology literacy definitions and skills for the basic technology literacy rubric not meeting the consensus cutoff were not considered after round three.

Data analysis of Delphi method study data differs from other forms of data analysis. The nature of a Delphi study follows an iterative data analysis process after each round. The analysis and feedback from round one structured the design of round two. The analysis and feedback from round two structured the design of round three. The data collected from round three is analyzed and formatted and reported back to the participants for their final verification. Analysis of each iterative round consists of reviewing the Qualtrics data for technology literacy definitions and skills/skill levels that have met the majority consensus level. Definitions and skills/skill level meeting the majority consensus level were compiled into a document and sent to participants for feedback.

Expected Outcomes of Study

The outcome sought at the end of the Delphi method study was an Academic Technology Literacy ASsessment (ATLAS) rubric. The design of the ATLAS was a combination of a holistic and analytic rubric. The rubric was a typical row and column setup with the rows being the application skill and the columns were the skill level. The field of the rubric was the consensus results from the modified Delphi method study. The rubric could be listed with each participating course with a technology component, so students would know what technology literacy skills they would need to be successful in the course.

Integration Questionnaire

Sample

The integration questionnaire addresses research question three. Research question three will look at how the ATLAS rubric would be integrated into an academic setting. Four academic levels at Montana State University-Bozeman had been identified at the course, department, college and university level. A single person from each of the levels was invited to participate in the study.

<u>Sample Methods and Size</u>

Sample selection for this section of the study also employed purposive sampling to select individuals from Montana State University that understood the steps required to integrate the ATLAS rubric. An individual was selected from each of the four academic areas: course, department, college, and university for a total of four participants. Although not considered an administrator, one faculty member from the course level was invited to participate. The criteria for the selection of the type of individual that was sought is as follows:

Course: A faculty member, i.e., Writ 101 instructor

Department: An individual acting in the capacity of an academic Department Head/Chair, i.e., Department Head/Chair of Chemistry

College: An individual acting in the capacity of an academic Dean, i.e., Dean of the College of Arts and Architecture.

University: An individual acting in the capacity of an academic assistant, associate, or provost, i.e., Executive Vice President for Academic Affairs and Provost

Organizational change can be strong when started with one participant that has success and then brings the idea to the larger group; this may be the course level faculty. A faculty member in a single course may not need the academic approval to place the ATLAS rubric in one course for one semester or academic year.

The recruitment of an individual from the university level was the first participant sought. This was done due to the number of meetings this level of individual attends; it might take a great deal of time and effort to recruit a participant at this level. During back and forth conversations at the university level, the course/faculty, and the college level were being recruited. The two individuals identified from the course/faculty and the college level also participated in the pilot study associated with this study. Invitation emails were sent out to the course/faculty and the college level. The course/faculty and the college level individuals responded back positively, agreeing to participate.

Instrument

The instrument used was an open-ended questionnaire that was administered using Qualtrics. This instrument identified steps needed to integrate the ATLAS rubric at the course, department, college and university level. The survey was administered electronically by sending the survey link to each participant once the modified Delphi method study had been completed. The questionnaire was active for seven days with a reminder sent out on day four and on day seven to those participants that have not responded (see Appendix L for the integration questionnaire). To provide as much flexibility as possible, the participants were given the option of filling out a Qualtrics online questionnaire or a face-to-face interview. The course/faculty and the college level participants selected the online questionnaire and were emailed the link to the Qualtrics integration questionnaire. The course/faculty and the college participant completed the integration questionnaire within the seven days. While conversations were still in progress at the university level, two invitations were sent out to department chairs/heads seeking participation. One of the department chairs/heads responded back positively, while the other did not respond at all. The department chair/head was given the same option of filling out a Qualtrics online questionnaire or a face-to-face interview.

The department chair/head participant selected the online questionnaire and was emailed the link to the Qualtrics integration questionnaire. The department chair/head participant completed the integration questionnaire within the seven days. During this time, a university representative was identified, invited and agreed to participate. The university participant was also given the option of filling out a Qualtrics online questionnaire or a face-to-face interview. The university participant selected the online questionnaire and was emailed the link to the Qualtrics integration questionnaire. The university participant completed the integration questionnaire within the seven days. Data collection for the integration questionnaire was closed, and data analysis began.

Data Collection and Analysis

All the participant's responses were collected and stored on the Qualtrics website in a secure; password protected location. I was the only person to have access to this location. The integration questionnaire was the last group of data collected. The purpose of this integration questionnaire was to explore what steps would need to be taken to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, department, college and university level. This was accomplished by asking four participants, one from each area, seven questions associated with integration or sometimes referred to the institutionalizing of a program/initiative. The following are the results of the integration questionnaire data collection.

The integration questionnaire and integrated informed consent form were individually sent to the four that agreed to participate. The integration questionnaire asked participants the same informed consent, demographic and seven integration questions except for the use of different respective identifiers in each question. The different respective identifiers were, for example, how feasible do you feel the integration of the ATLAS within your/the (course, department, college, and university) as a whole. For example, the word university was replaced with the respective identifier of, course, department, college, and university. This was done for each of the seven questions.

The responses from the integration questionnaires for the four areas (course, department, college and university) were then analyzed (see Appendix M for the four participants individual responses from their respective areas). From the seven integration questions, seven categories were identified. The seven emerging categories were: feasibility, governance (policies and procedures), challenges, advantages, opportunities, resources (financial and personnel), and value. Tables were then created with each category and the associated responses from each of the four participant's areas associated with their respective categories. A content analysis was conducted resulting in one grand theme for all of the responses; this grand theme is a starting point. This question asked participants how feasible it would be to integrate the ATLAS at each of their respective levels. Except for the university level, all felt that the integration of the ATLAS was feasible to highly feasible. With a University of 15,000 plus students, it is understandable how it would not be feasible to integrate the ATLAS university-wide. Three of the participants feel the ATLAS can feasibly be integrated. Feasible means that something is possible, achievable, practical, all of which need a starting point. For the course participant, they see a starting point for integration of the ATLAS by just adding the ATLAS even though some of the classes may not need the assessment areas like spreadsheets or database knowledge.

Expected Outcomes of Study

The anticipated outcome for research question three was for each of the five areas to identify what steps that would need to be taken to integrate the Basic Academic Technology Literacy Rubric.

Timeline – Data Collection and Analysis

The data collection and analysis timeline for this study was during the spring 2018 semester. This timeline was selected to coincide with faculty availability and contracts. The study was projected to start the second week in January 2018 and finish the last week in April 2018 for a total study duration of 107 days, or approximately 15 weeks.

Research Validity

Trustworthiness

A Delphi method study is primarily a “structured communication” (Linstone & Turoff, 1975, p.3). This structured communication typically consists of three rounds of information gathering to build a consensus related to a topic (Norman, 1969). The first round typically employs an open-ended questionnaire that is qualitative (Hallowell & Gambatese, 2010; Murry & Hammons, 1995; Skulmoski et al., 2007). The next two rounds were quantitative and were created from information from each subsequent round.

The nature of the Delphi method seeking consensus helps to increase authenticity, trustworthiness, dependability, credibility, and transferability. The repeated surveys, analysis and providing feedback to participants for review and comments (member checking) allowed the information to be reduced to possible consensus by providing the point of view of each participant. Autonomy of participants was also preserved during the study because all interaction with participants were via e-mail and the internet with the point-of-contact being controlled by the researcher.

The authenticity of a research study was where the researcher strives to ensure that the behavior and evaluation of the study are unaffected by bias and admirable (James, 2008). The mechanics of the Delphi study where the results from round one were included in the feedback loop as well as the creation of the subsequent round(s), reducing the opportunities for bias. This continual feedback loop provided opportunities to address any biases that arise rendering the study as authentic as possible.

Dependability/reliability is the process where the researcher provides an audit trail of documenting the data, decisions methods and the results (Schwandt, 2007). The process of the Delphi method provided the audit trail by continually providing feedback to the participants regarding their responses. Subsequent surveys were entirely dependent on the results of the previous survey. This audit trail provided readers with a traceable mechanism for possible replication.

The repeated surveys, analysis and providing feedback to participants for review and comments (member checking) allowed the information to be reduced to the point of consensus. The process of constant feedback and seeking consensus requires all participants to be active at every level of the study. Even though the three rounds of surveys for this Delphi were closed question surveys, the process of creating the subsequent surveys was created from the results of the past surveys. The results were entirely the results of the participants. With the outcome of the study focused on consensus for each of the skill items, the researcher's position in the process was neutral acting as more of a facilitator of the data from one round to the next.

The instruments used in this survey could be generalized to establish a rubric for many if not all academic disciplines. Instrument generalization refers to establishing a generic rubric with skill levels across the top and the items/objects being assessed along the left side of the rubric. This approach could be used for a single course such as elementary, intermediate and advanced surveying or a complete degree such as civil engineering. For the Surveying courses, a survey listing all skills required and the skill levels could be created and distributed to Professional Land Surveyors (PLS). The result of the Delphi study conducted with PLS's would provide the instructors in the program a list of skill outcomes for each course level.

Validity and Reliability

Informational gathering devices/instruments such as tests, surveys, and questionnaires have many of the same characteristics and often follow the same guidelines for validity and reliability. Validity is the extent to which a test/survey measures what it has been designed to measure (Cantor, 1992). Associated with a test/surveys validity was the reliability of the instrument. Reliability refers to how well does the instrument gather the intended information consistently and reliably (Cantor, 1992). The authors of Standards in Educational and Psychological Testing (American Educational Research Association [AERA], 1999) look at reliability to have a level of precision and the "consistency of scores across replications of a testing procedure, regardless of how this consistency is estimated or reported" (p. 33).

The validity of a Delphi methods study was largely dependent on the participants, not only their expert constructs knowledge but also their willingness to participate in the study until completion. Goodman (1987) and Hasson, Keeney, and McKenna (2000) indicate the biggest threat to internal validity was participant retention/mortality, which was directly associated with response rates of Delphi Studies. To increase survey responses, Dillman, Smyth, and Christian (2014) suggested employing social exchange, which engages people/participants when the benefits of participation offset the sacrifices. Dillman, Smyth, and Christian (2014) suggest doing this by engaging the participants in several ways. A few of their suggestions to engage the participants can be done by:

- **Providing Information about the Survey:** Explain items such as why and how they were selected, the reason for conducting the survey and the audience that will benefit from the information they provide.
- **Ask for Help/Advice:** Appealing to people's innate response to help when asked has been shown to increased response rates by 19% (Mowen & Cialdini, 1980). This can be done by simply including phrasing such as "your participation would really help us out."
- **Say Thank You:** Verbal appreciation by simply saying "thank you" or "your help with this study is greatly appreciated." In some surveys conducted, Dillman,

Christenson, Carpenter, and Brooks (1974) found that verbal appreciation increased response rates close to 100%.

- **Give a Tangible Reward:** Offer small monetary incentives for participating in the survey.
- **Make it Convenient to Respond:** Provide an easy method for participants to respond to the survey. If the survey is mailed, provide them with a postage paid envelope to send survey back. If the survey is to be implemented using the internet, make sure that all electronic links are valid.
- **Make the Questionnaire Short and Easy to Complete:** Research has identified the number of pages is not an indicator of low response rates (Heberlein & Baumgartner, 1978), but response rates slightly decrease if the number of questions makes the questionnaire long (Leslie, 1997).
- **Ensure Confidentiality and Security of Information:** Explain how the information was used and what steps were taken to ensure confidentiality and how the information they provide will remain secure.

These suggestions were incorporated when writing the study invitation letters to the participants and the surveys. Information about the survey, avenues for advice, help during the process, the methods to respond and a tangible reward (which was awarded at the completion of the study) were all be included as part of the invitation letter. Methods of confidentiality of the survey responses were also be included in the invitation letter. Included with the tangible reward at the end of the study was a thank you for participating in the study.

Reliability refers to how well does the instrument gather the intended information consistently and reliably (Cantor, 1992). Reliability of a Delphi methods study was not as easily obtained or as applicable to traditional types of reliability. This was due to the nature of the study and the design of the survey instruments typically using open-ended questions (Fish & Busby, 1996). Sample size and composition were key aspects essential for the reliability of Delphi studies (Adler & Ziglio, 1996; Clayton, 1997; Linstone & Turoff, 1975; Skulmoski et al., 2007). Linstone & Turoff suggested that group sizes larger than 11 produce an acceptable error and sample sizes of 10-15 are common for Delphi method studies (1975). In addition to sample size, the composition of the sample of participants was a critical component of the studies reliability. Clayton asserts that the expertise of the panel of participants was directly associated with the reliability of the study, and diligence of their selection is critical (1997). Adler and Ziglio (1996) suggest that panel participants should meet four requirements/criteria that aid in establishing them as experts: 1) Knowledge and experience with the issues under investigation; 2) Capacity and willingness to participate; 3) Sufficient time to participate; 4) Effective communication skills.

In this study, the four criteria shaped the selection of participants in the following manner: knowledge and experience with the issues under investigation were the first criteria used to select not only the participants but also the setting. I had firsthand knowledge and experience with the material taught in CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office as well as working with the instructors. With this firsthand knowledge and experience, I am positioned well to know that this cohort was the ideal to address research questions one and two of this study. As an instructor for over 17 years, I understand the inherent drive instructors have to help students succeed. It was this inherent drive that establishes their capacity and willingness to participate. Also, as part of this inherent drive instructors have to help students, instructors needed to find sufficient time to participant in this study. I adjusted the timeline to allow participants ample time to complete the survey if allotted time was deemed insufficient. As instructors in higher education, one of the elemental characteristics of an instructor was effective communication skills. These skills were typically demonstrated in written and verbal form. For this study, participants communicated via email requiring efficient and effective writing skills.

Skulmoski et al. (2007) suggested that reliability could be improved if the researcher remained in constant communication with the panel throughout the study. This constant communication started from the initial invitation to participate through the final study results. Vital to the process was constant, systematic feedback (Adler & Ziglio, 1996; N. Dalkey & Helmer, 1963; Delbecq et al., 1975; C.-C. S. Hsu, Brian A, 2007; Linstone & Turoff, 1975).

Cooper & Schindler (2003) suggested consistency was the basis of reliability. The focal point of consistency for a Delphi method study was centered on the appropriate number of participants, 10 to 15 participants was a sufficient number to achieve consensus (Delbecq et al., 1975; Okoli & Pawlowski, 2004). Keeney et al. (2001) emphasized that large amounts of data collected from first round open-ended questions and a long, drawn-out survey strained the participants, and in turn, threatened the validity and reliability of the study.

Attainment and preservation of the sample size and composition were vital to this study to ensure validity, reliability, and consensus. In addition to the proper number of participants was the retention of the initial invited sample of participants. Attainment and preservation were done during this study by constant communication with participants for the initial invitation to participate through to the study's conclusion. This constant communication was done primarily via e-mail with phone calls as a secondary method of contact. In addition to the steps previously mentioned, Conti's (2012) eight items to enhance the reliability was incorporated to enhance the reliability of this Delphi method study:

- The purpose of the study, as well as the process to be used, was discussed with the participants.
- The participants have access to the informed consent and the confidentiality Agreement, and they will have their concerns addressed at all points before or during the study.
- The participants were informed that their participation was voluntary and that they can withdraw at any time without penalty.
- The participants were informed that there are no wrong or right answers.
- The participants' identities were concealed and coded to ensure anonymity.
- Each participant had an opportunity to ask questions to ensure they understood the process.

- Before the start of the study, each participant was asked to read and sign the informed consent form.
- Contact information was provided to each participant should further questions or concerns arise during the study.

To convey this information to the participants, each of Conti's eight items was included in the initial study invitation email. In addition to Conti's eight items used to enhance reliability, Dillman et al. (2014) seven items to engage participants will also be employed during the study. An additional measure of conducting a pilot study of the developed instrument will also be used to test for instrument's validity and reliability.

Ethical Considerations

Research that involves the collection of data from people by people required the researcher to follow certain procedures to protect the participant's health, safety, welfare and identity (Punch, 2013). In most cases, this was done through a formal process involving an Institutional Review Board (IRB) or similar ethical review board. This process was in place to protect the institution, the researcher and most importantly, the participants (Creswell, 2009; Savin-Baden & Major, 2013).

Ethical Review Boards - Institutional Review Board (IRB)

The institution this research was conducted at requires the researcher to pass a Research Ethics and Compliance Training conducted online by CITI Program prior to conducting any research involving human subject. Once the researcher had successfully completed the required CITI training, an application to conduct research was submitted to the appropriate ethical review board. At this institution that board was the Institutional Review Board (IRB). Researchers will apply for one of three types of review; a request for exemption, an expedited or a full committee review. Consultation with this dissertation committee's co-chairs and the chair of the institutions IRB, it was determined that a request for exemption would be filled out due to there being essentially no risk to the participants. As part of the IRB application, researchers will also submit an informed consent form. The informed consent form needs to answer, "Do the people I am studying have full information about what the study will involve. Is their 'consent' to participate freely given – fully voluntary and uncoerced." (Miles & Huberman, 1994, p. 291). Additional information to address as part of the narrative of the informed consent was what the study was about and what the participants were asked to do. The narrative also covered how the data was collected, from whom it was being collected, and how the participants were selected. Risks to the participants, as well as any benefits to the participants such as incentives for participation, were explained. Also explained was how the data would be handled after collected. Was it be available to others, and how, where and for how long the data will be kept and is it secure (Miles & Huberman, 1994; Savin-Baden & Major, 2013). For this study, the primary IRB application was submitted explaining each of the four surveys (see Appendix N for IRB application for this study). At the start of survey two, three and four, a request for modifications/amendments were submitted explaining the new sample and instruments for each survey.

Confidentiality and Anonymous

Confidentiality and anonymous were two terms that, at times, were used interchangeably but were far from interchangeable. As part of an IRB application, a statement was provided as to how the participants and their information was protected. If a researcher states that a participant and their information will remain confidential, the researcher may collect some data about the participant. Participant demographics was typical information that was collected regarding participants. The researcher must be cautious as to the amount of demographic information collected. If the sample was from an education department within a small college in the mid-west and the researcher asks for participants to provide, age or age range, gender, years at this institution, highest degree earned and years with the department, that may be too much information. With all of this information, the identity of the participants could be identified with a small amount of research. Only collect demographic information that was vital to the study (Miles & Huberman, 1994). Stating in the IRB narrative that the participant's identification will remain anonymous means that no demographic information was collected in any form at any time during the study. This means that there were no "breadcrumbs" leading back to the participant.

The use of online survey software like Qualtrics and SurveyMonkey is very common for collecting data from participants. As part of this collection process, the software, by default, keeps track of the participant's Internet Protocol (IP) address. A participants IP address is similar to their mailing address. This is how electronic information finds its way to your computer. The option to collect this information will need to be turned off if you state that the participants of the study are to remain anonymous.

Chapter Three Summary

Chapter three restated the purpose of the study and the research questions. The research design and rationale section set the stage for the study by presenting the pragmatic paradigm and how it framed the study. The rationale for using the Delphi method methodology and more specifically a modified Delphi method and how a consensus would be used as a means of data analysis was also presented. In the positionality and reflexivity section, it was explained what position the role of the researcher holds in the research process and how the researcher operates within the study. The development of the modified Delphi instrument section details the use of a single heuristic evaluation and a pilot study of the modified Delphi method provide key data for the creation of the modified Delphi method study instrument. In the research setting and population section, the site where the study took place and who the population participants were, was explained. The sample section identifies the cohort of participants that provided the data to address the research questions presented in this study. The sampling method and size section identified what sampling method was used to select the participants as well as how many participated in the study. The study instruments section detailed the instrument to be used for the modified Delphi method study, which addressed research questions one and two, and the integration questionnaire addressing research question three. The section for data collection and analysis detailed how the data was collected and analyzed as well as the timeline of the study. Research validity was the last section presented in this chapter discussing methods for assuring the validity and reliability of the study.

CHAPTER FOUR

RESULTS

Introduction

As initially stated in chapter one, the purpose of this modified Delphi method study was to first, identify exemplary technology literacy definitions from current technology literacy definitions. The second purpose and center of this study was the development of the Academic Technology Literacy ASsessment (ATLAS) rubric. The final purpose of this study was to identify the steps needed to implement the ATLAS at the course, department, college and university level. Three research questions were designed to address these areas. To address the three research questions, this study was conducted in four parts; a single heuristic evaluation, a pilot study of the modified Delphi method study, the modified Delphi method study, and an integration questionnaire.

The roadmap for this chapter begins with restating the purpose of this study followed by restating the research questions. Following the research questions is a brief overview of the methodology of the study primarily focusing on the sequential data collection methods. The chapter is then organized by presenting the data in that sequential order starting with the heuristic evaluation, then the pilot study testing the modified Delphi method study, then the modified Delphi method study, and finally the integration questionnaire. As part of the results, demographic information was collected for all three data collection methods and placed in this chapter. The reasoning for including the demographic information in this chapter was to keep the SME's demographic information connected to the data they produced. This is typical of a Delphi method study.

The purpose of this chapter was to present the data collected during the single heuristic evaluation, a three round modified Delphi method study and the integration questionnaire. The single heuristic evaluation participants were three experts from within higher education with a strong technology knowledge base. The three participants reviewed 25 technology literacy definitions and reduced them down to 10 technology literacy definitions that were included in the pilot study of the modified Delphi method survey as well as the main modified Delphi method study. The sequential, three rounds of the modified Delphi method study collected data for the creation of the Academic Technology Literacy ASsessment (ATLAS) rubric. The 10 participants for this modified Delphi method study were from a cohort of instructors that taught CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office during the 2017-2018 academic year. The integration questionnaire was used to collect data on how the ATLAS could be integrated into a course, into a department in its entirety, into a college in its entirety, then finally how could the ATLAS be institutionalized within the entire university. A single participant was selected from the course (faculty), the department (department head/chairs), the college (assistant, associate, and deans), and the university (provost's) levels.

The single heuristic evaluation and the first question of the modified Delphi method study addressed research question one - How do technology experts in higher education define technology literacy? The second part of the modified Delphi method study addressed research question two - How do technology experts in higher education align basic academic technology literacy skills with skill levels to create an academic technology literacy assessment rubric? Research question three focused on the integration of the ATLAS - What steps would need to be taken to integrate the basic academic technology literacy rubric at the course, department, college and university level?

Heuristic Evaluation Results

The single heuristic evaluation was the essential first step to the modified Delphi method study. The results of the single heuristic evaluation were used as the first part of the modified Delphi method study. The modified Delphi method study asked participants to identify an exemplary technology literacy definition that would be used to accompany the ATLAS rubric.

Participants

The participants for the single heuristic evaluation consisted of a panel of three experts selected using the snowball sampling method discussed in chapter three. Two of my colleagues were selected to provide names of participants that they felt would be able to meet the requirement of the single heuristic evaluation. The criteria for selection of the two initial participants was a well-rounded understanding of technology. This understanding of technology was primarily grounded in the technology used in an academic setting at the higher education level. As part of the single heuristic evaluation, all participants were asked to provide demographic information.

Demographics

Participants were asked to provide demographic information to identify them as experts related to the criteria for the single heuristic evaluation, but not to go as far as to identify them personally. This was accomplished by not asking the participants to identify their location such as institution they are employed at or state the institution is located in (see Table 12). Table 12 helps to visualize the extensive years of higher education teaching experience, coupled with the high level of technology literacy makes all three participants ideal evaluators of the single heuristic evaluation. All three of the participants were male (100%), with one of the participants within the age range of 34-44 (33.33%), one within the age range of 55-64 (33.33%), and one within the age range of 65-74 (33.33%). All three (100.00%) single heuristic evaluation participants hold a doctorate degree. Two of the participants hold the rank of full professor (66.67%), and one is a professional staff member. All the participants have been working in higher education over 10 years with one (33.33%) of the participants having 15-20 years of experience in higher education, while two (66.67%) have over 25 years of experience in higher education. All three participants (100.00%) considered themselves proficient overall with technology.

Table 13. Characteristics of Participants – Heuristic Evaluation (N = 3)

Demographics	*N*	%
Gender		
Male	3	100.00%
Female	0	0.00%
Age range		
Under 18	0	0.00%
18 – 24	0	0.00%
25 – 34	0	0.00%
35 – 44	1	33.33%
45 – 54	0	0.00%
55 – 64	1	33.33%
65 – 74	1	33.33%
75 – 84	0	0.00%
Over 85	0	0.00%
Highest degree or level of school completed		
Less than a high school diploma	0	0.00%
High school degree or equivalent (e.g. GED)	0	0.00%
Some college, no degree	0	0.00%
Associate degree (e.g. AA, AS)	0	0.00%
Bachelor’s degree (e.g. BA, BS)	0	0.00%
Master’s degree (e.g. MA, MS, MEd)	0	0.00%
Professional degree (e.g. MD, DDS, DVM)	0	0.00%
Doctorate (e.g. PhD, EdD)	3	100.00%
Title of current position		
Instructor	0	0.00%
Assistant Professor	0	0.00%
Associate Professor	0	0.00%
Full Professor	2	66.67%
Non-Tenure Track	0	0.00%
Adjunct	0	0.00%
Professional Staff	1	33.33%
Other	0	0.00%

Table 13. Characteristics of Participants – Heuristic Evaluation (N = 3) (continued)

Demographics	*N*	%
Number of years working in Higher Education		
1-5	0	0.00%
5-10	0	0.00%
10-15	0	0.00%
15-20	1	33.33%
20-25	0	0.00%
Over 25	2	66.67%
Overall technology literacy/knowledge - digital and non-digital		
Novice	0	0.00%
Advanced Beginner	0	0.00%
Competent	0	0.00%
Proficient	3	100.00%
Expert	0	0.00%

Results

The single heuristic evaluation consisted of a demographic section in the front and the single heuristic evaluation with the 25 technology definitions following. The single heuristic evaluation instructed participants to read each definition and evaluate the definition as to how it meets each of the heuristic criteria. The three heuristics chosen were adopted from a computer science heuristic that focused on usability. If a definition meets all three of the heuristics, select all three boxes check marks, two of the heuristics select the appropriate boxes, one of the heuristics check the appropriate box and select the last box if none of the heuristic criteria were met. The three heuristics were as follows as well as a no heuristic criterion met option.

Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest.

Minimal language redundancy: The technology literacy definition should minimize redundancy in its language.

Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology.

No heuristic criteria met

The maximum score participants could give a definition was nine, none of the technology literacy definitions received this score. A score of nine was only possible if all three participants felt the technology literacy definition met all three heuristics. Eight was the highest score any definition scored, meaning one participant felt the definition lacked one of the heuristics. One participant did not feel the definition met the second heuristic: minimal language redundancy. In contrast to this one participant, the heuristic of minimal language redundancy was the most selected heuristic. This heuristic was selected 37 times compared to the second most selected heuristic of human-centered syntax being selected 26 times. Ten definitions were identified to move on to be included in the modified Delphi method study. I randomly selected 10 as the number to be respective of the evaluators time. The cutoff score of four was selected because the last definition scoring a four was the tenth definition creating a logical cut-off number. A comment by one of the participants was why the sources of the technology literacy definition were not included. The literature and background information were not provided as part of the survey since participants might have been biased in their responses (see Appendix O for Single Heuristic Evaluation Results).

The reduction of the 25 technology literacy definitions to 10 technology literacy definitions signified a certain level of them being exemplary. Of the 10 technology literacy definitions identified, five used the SETDA definition as the basis for their definitions. Commonalities within the technology literacy definitions centered around the words “ability/abilities”:

- ability of a person to use
- skills and the ability to use
- individual’s abilities to adopt
- ability to acquire
- ability to responsibly use
- ability of an individual to use
- ability to gather
- ability of students to use
- ability to navigate through society

These 10 technology literacy definitions identified had a common thread of problem-solving, communication, responsibility and lifelong. Some of the definitions equated these as the demands of learning in the 21st century. With the use of the word, ability/abilities suggested that everyone was technologically literate, just at varying levels.

Pilot Study – Modified Delphi Method Study Results

A pilot study is a small-scale representation of a full-scale qualitative or quantitative study that is conducted over a shorter timeframe (Gay et al., 2011). The next step in the research process was to conduct a pilot study of the modified Delphi method study, here forward referred to as the pilot study. The pilot study was utilized to work out any issues and concerns with the untested instruments such as sample selection, instrument design and implementation, data collection methods and mechanics, data analysis methods and validity and reliability (Schreiber, 2008). The first part of the study consisted of 10 technology literacy definitions. The second part was the section containing the ATLAS survey, and the third part was a dedicated section addressing issues with validity and reliability. Four participants were selected to participate in this pilot study.

Participants

The participants for the pilot study were selected using convenience sampling from the Teaching Excellence Action Committee (TEACh) located on the Montana State University campus to pilot the instrument for face and content validity and reliability. As part of the pilot study, all participants were asked to provide demographic information. From this point forward, pilot study refers to the modified Delphi method pilot study.

Demographics

As part of the pilot study, participants were asked to provide demographic information to identify them as experts related to the criteria for the pilot study, but not to go as far as to identifying them personally (see Table 14). Table 14 helps to visualize the extensive years of higher education teaching experience, coupled with the high level of technology literacy makes all four participants ideal evaluators of the pilot study. All four of the participants are male (100%), with two of the participants within the age range of 34-44 (50.00%), one within the age range of 45-54 (25.00%), and one within the age range of 55-64 (25.00%). Three of the participants (75.00%) hold a master's degree, while one of the participants holds a professional degree (25.00%). One of the participants holds the rank of assistant professor (25.00%), one of the participants holds the rank of associate professor (25.00%), one of the participants holds the rank of full professor (25.00%), and one is a professional staff member (25.00%). Years working in higher education vary from one participant have been working in higher education 5-10 years (25.00%), one of the participants has 10-15 years (25.00%) of experience in higher education, one of the participants has 15-20 years (25.00%) of experience in higher education, and one (20.00%) has over 25 years of experience in higher education. Two of the participants (50.00%) consider themselves proficient, while one considers themselves an expert (25.00%) with technology overall.

Table 14. Characteristics of Participants – Pilot Study –
Modified Delphi Method Study (N = 4)

Demographics	*N*	%
Gender		
Male	4	100.00%
Female	0	0.00%
Age range		
Under 18	0	0.00%
18 – 24	0	0.00%
25 – 34	0	0.00%
35 – 44	2	50.00%
45 – 54	1	25.00%
55 – 64	1	25.00%
65 – 74	0	0.00%
75 – 84	0	0.00%
Over 85	0	0.00%
Highest degree or level of school completed		
Less than a high school diploma	0	0.00%
High school degree or equivalent (e.g. GED)	0	0.00%
Some college, no degree	0	0.00%
Associate degree (e.g. AA, AS)	0	0.00%
Bachelor’s degree (e.g. BA, BS)	0	0.00%
Master’s degree (e.g. MA, MS, MEd)	3	75.00%
Professional degree (e.g. MD, DDS, DVM)	1	25.00%
Doctorate (e.g. PhD, EdD)	0	0.00%
Title of current position		
Instructor	0	0.00%
Assistant Professor	1	25.00%
Associate Professor	1	25.00%
Full Professor	1	25.00%
Non-Tenure Track	0	0.00%
Adjunct	0	0.00%
Professional Staff	1	25.00%
Other	0	0.00%

Table 14. Characteristics of Participants – Pilot Study – Modified Delphi Method Study (N = 4) (cont'd)

Demographics	*N*	%
Number of years working in Higher Education		
1-5	0	0.00%
5-10	1	25.00%
10-15	1	25.00%
15-20	1	25.00%
20-25	0	0.00%
Over 25	1	25.00%
Overall technology literacy/knowledge - digital and non-digital		
Novice	0	0.00%
Advanced Beginner	0	0.00%
Competent	1	25.00%
Proficient	2	50.00%
Expert	1	25.00%

Results

The primary purpose of the pilot study was to test the form, function, validity, and reliability, of the instrument. Consensus levels were not the primary objective for the pilot study. A key component of validity and reliability is the form and function of the instrument: does the instrument look and function like a survey. Validity of the instrument refers to: does the instrument measure what it is intended to measure, and reliability refers to the consistency of the instrument reporting back the same results, repeatedly. As part of the instructions, participants were informed the goal of the modified Delphi method study, not the pilot study, was to reach consensus level of 80% for each question in the technology literacy definitions section and the non-related skills section over the course of three rounds. The 10 technology literacy definitions from the first part, and all of the task/skills in the second part moved forward to the modified Delphi method study instrument. The first part of the pilot study asked participants to identify which technology literacy definitions they deemed most relevant. With only four participants, none of the results from the first two sections met the 80% consensus level (See Appendix O for Pilot Study Results).

The second part of the pilot study, consisting of only one round, asked participants to match the academic technology literacy skills with the skill level they felt was most appropriate. The findings associated with the pilot study for of the ATLAS skills sections; basic computer skills, word processing, spreadsheets, database, presentations, and email communications were skewed and inconclusive. Twenty-two questions for basic computer, 21 questions for word-processing, 28 questions for spreadsheet, 19 questions for database, 26 questions for presentations and 17 questions for e-mail communication skills for a total of 133 questions. Reviewing the finding for each of these skills sections, I noticed that many of the responses were in the proficient and expert sections. For example, two of the four participants felt that you needed to be an expert to copy and delete files as part of basic computer skills. As identified in the positionality and reflexivity section in chapter three, I have an extensive computer background, both hardware and software allowing more in-depth interpretations of the findings.

To better understand these findings, I looked at the results for each participant individually. I noticed that one participant responded to all but two of the 19 questions for database skills as a novice, meaning they felt that a novice database user would be able to handle 17 of the 19 tasks. I felt that this was unlikely. Looking at the finding as a whole, this would not have surfaced, but looking at the responses of each individual this pattern came to the surface in other skills sections. I felt that this was a result of a survey design decision. The first was, that by design participants must answer each question before moving on to the next skill. This requires a response for each skill before moving to the next. This requirement may have forced the SME participants to select a skill just to satisfy the requirement to move on. The second design decision that may have caused SME participants just to select a skill was that I did not provide a neutral response option such as N/A or do not know. Consideration was also given to the fact that the participant may not have been skilled in that section, such as database skills so that the participant may have selected the same skill level for all of them as their own neutral response option. For the pilot study, the mechanics of the instrument was the primary focus. To aid participants with each pairing of the task to skill level, a question was posed: A/An (novice, advanced beginner, competent, proficient, expert) the user should be able to perform this task.

The third, and concluding section of the pilot study, asked participants questions related to the validity and reliability of the modified Delphi method study survey and also to provide any additional comments. This section was a four scale Likert design, using Agree, Somewhat Agree, Somewhat Disagree and Disagree as item choices. The validity section consisted of four questions (see Table 15), while the reliability section consisted of seven questions (see Table 16).

Table 15. Validity of Pilot Study Instrument

Question	Agree	Somewhat Agree	Somewhat Disagree	Disagree	N=
Layout of the survey is pleasant to the eye.	2	1	1	0	4
Style/Fonts used for the survey are professional and of consistent typeface.	2	2	0	0	4
Survey is easy to navigate.	3	1	0	0	4
Survey is free of mechanical errors -participants can respond to all questions.	3	1	0	0	4

Table 16. Reliability of Pilot Study Instrument

Question	Agree	Somewhat Agree	Somewhat Disagree	Disagree	N=
The wording is clear and understandable - reader did not find the need to rewrite or paraphrase.	2	1	1	0	4
Survey is free of ambiguous questions.	2	1	1	0	4
Survey is free of double-barreled questions.	3	1	0	0	4
Survey is free of loaded questions.	3	1	0	0	4
Survey is free of leading questions.	3	1	0	0	4
Survey questions are presented in a logical order and free of unrelated topics.	3	0	1	0	4
The likelihood is high that the target audience would have the knowledge to answer the questions.	3	0	1	0	4

At the end of each section, participants were provided a space for comments. The participants provided very little qualitative feedback. The Comments provided in the pilot study, helped shape the modified Delphi method study. One of these changes was a comment made about the labeling of the first ATLAS skills section. The first skills section was labeled Basic Computer Skills. It was commented that if you are labeling the section as “basic” computer skills why the different skills levels beyond basic/novice. The final modified Delphi method study reflected this change, and the section was relabeled to Computer Skills.

The only comments participants provided were for the basic computer and word processing skills. The two comments for the basic computer skills were as follows:

- “I wonder about the title ‘Basic Computer Skills’ -- it made me wonder if the skills were ‘Basic’, but I can see some of them requiring some specialized knowledge. “
- “I'm answering as to my own skills. I was not clear if that is what you want.”

The Basic Computer Skills title in the modified Delphi method study was changed to just Computer skills as a result of this comment.

The one comment that was provided for word-processing is as follows:

- “In most word processing programs I have no problem, but google docs can be challenge to change formatting, similarly InDesign can be difficult for me.”

In summary, the results of the pilot study for the ATLAS skills sections; basic computer skills, word processing, spreadsheets, database, presentations, and email communications were skewed and inconclusive. Reviewing the finding for each of these skills sections, I noticed that many of the responses were in the proficient and expert skill level for tasks/skills that should possibly be rated lower than that. For example, 75% of the participants felt that a person needed to be an expert to create a new word processing document. Reflecting on my experience with this skill and the software. I would match this skill with the novice skill level. This may have been a result of not providing a neutral response option such as N/A or do not know. The results and comments from the pilot study were used to amend the final modified Delphi method study.

Modified Delphi Method Study Results

The modified Delphi method study consisted of three rounds. Each round had two parts: technology literacy definitions and ATLAS skills. The modified Delphi method study was created from the results of the single heuristic evaluation where 25 technology literacy definitions were reduced to 10, which in turn were added to the survey instrument along with the ATLAS skills. The pilot study also helped shape the modified Delphi method study by identifying changes that were being made to form and function of the survey instrument that in turn added clarity and possibly increased responses. The following are the results of the modified Delphi method study.

Participants

The participants for this modified Delphi method study were invited by email to participate in the study from a cohort of instructors that teach CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office during the 2017-2018 academic year. Twenty-nine instructors were identified to be teaching one of the CAPP courses; 10 completed the three-round modified Delphi method study. As part of the modified Delphi method study, all participants were asked to provide demographic information.

Demographics

A vital part of any Delphi method study is the selection of Subject Matter Experts (SME). As part of the modified Delphi method study, participants were asked to provide demographic information to identify them as SME's related to the criteria for the modified Delphi method study, but not to go as far as to identify them personally. The following information and table (see Table 17) presents the diversity and the extensive years of higher education teaching experience, coupled with the high level of technology literacy makes all 10 SME's ideal participants for the modified Delphi method study. Of the 10 modified Delphi method study participants, six are male (60.00%), and four are female (40.00%). Two of the participants are within the age range of 34-44 (20.00%), four are within the age range of 45-54 (40.00%), and four are within the age range of 55-64 (40.00%). One of the participants holds an associate degree (10.00%), one of the participants holds a bachelor degree (10.00%), five of the participants (50.00%) hold a master's degree, and three of the participants hold a doctorate degree (30.00%). Twenty percent of the participants hold the rank of instructor. One of the participants holds the rank of associate professor (10.00%), two of the participants hold the rank of full professor (20.00%), three of the participants are adjunct (30.00%), and two are professional staff members (20.00%). The number of years participants have been working in higher education varies from two participants have been working in higher education 1-5 years (20.00%), and two of the participants have 5-10 years (20.00%) of experience in higher education. Two of the participants have 15-20 years (20.00%) of experience in higher education, two of the participants have 20-25 years (20.00%) of experience in higher education, and two (20.00%) have over 25 years of experience in higher education. One participant (10.00%) considers themselves competent with technology overall. Five of the participants (50.00%) consider themselves proficient, while four considers themselves experts (40.00) with technology overall. Since all 10 of the SME participants that started round one are the same 10 SME participants that completed round three, the demographic characteristics of the SME participants were only collected for round one.

Table 17. Characteristics of SME Participants – Modified Delphi Method Study (N = 10)

Demographics	*N*	%
Gender		
Male	6	60.00%
Female	4	40.00%
Age range		
Under 18	0	0.00%
18 – 24	0	0.00%
25 – 34	0	0.00%
35 – 44	2	20.00%
45 – 54	4	40.00%
55 – 64	4	40.00%
65 – 74	0	0.00%
75 – 84	0	0.00%
Over 85	0	0.00%
Highest degree or level of school completed		
Less than a high school diploma	0	0.00%
High school degree or equivalent (e.g. GED)	0	0.00%
Some college, no degree	0	0.00%

Table 17. Characteristics of SME Participants –
Modified Delphi Method Study (N = 10) (cont'd)

Demographics	*N*	%
Associate degree (e.g. AA, AS)	1	10.00%
Bachelor's degree (e.g. BA, BS)	1	10.00%
Master's degree (e.g. MA, MS, MEd)	5	50.00%
Professional degree (e.g. MD, DDS, DVM)	0	0.00%
Doctorate (e.g. PhD, EdD)	3	30.00%
Title of current position		
Instructor	2	20.00%
Assistant Professor	0	0.00%
Associate Professor	1	10.00%
Full Professor	2	20.00%
Non-Tenure Track	0	0.00%
Adjunct	3	30.00%
Professional Staff	2	20.00%
Other	0	0.00%
Number of years working in Higher Education		
1-5	2	20.00%
5-10	2	20.00%
10-15	0	0.00%
15-20	2	20.00%
20-25	2	20.00%
Over 25	2	20.00%
Overall technology literacy/knowledge - digital and non-digital		
Novice	0	0.00%
Advanced Beginner	0	0.00%
Competent	1	10.00%
Proficient	5	50.00%
Expert	4	40.00%

Round One Results

The following are the results of the round one of the modified Delphi method study. Round one was the first of three rounds of the modified Delphi method study to identify an exemplary technology literacy definition and match up skills with the appropriate skill level. For the modified Delphi method study, round one responses were used as the basis for the round two instrument. The modified Delphi method study followed the same protocol as the pilot study.

As noted earlier, the modified Delphi method study – pilot study and the modified Delphi method study have the same questions as far as the informed consent, demographics, technology literacy and modified Delphi method study. As part of the instructions, participants were informed the goal of the modified Delphi method study was to reach a consensus level of 80% for each question over the course of three rounds. Responses that met the 80% consensus cut-off value in each round were added to the exemplary technology literacy definition list and the ATLAS rubric. Items that did not meet the consensus cut-off value at any of the four rating (excellent to poor), were removed from the survey's subsequent rounds.

The 10 technology literacy definitions section (round one, part one) asked SME participants to rate each technology literacy definition from excellent to poor. The 10 technology literacy definitions were extracted from the literature verbatim, and similar to the single heuristic evaluation, the source of the definitions was not included as to not bias the ratings. As part of the questions, participants were asked to fill in the blank to this question, "I feel this is a/an (excellent, good, fair, poor) example of a technology literacy definition" by selecting one of the choices (see Appendix Q for the results of this section). Round two did not have any technology literacy definitions meet the 80% cut-off value. Since none of the technology literacy definitions met the 80% cut-off value, all 10 definitions were included in round two.

After the first round of the modified Delphi method study, no trends started to develop, and no technology literacy definition reached the 80% consensus cut-off level. Of the 10 technology literacy definitions, six or 60% of the technology literacy definitions had responses spread over all four of the levels from excellent to poor. Only one of the technology literacy definitions met what would be considered a majority consensus cut-off level of 60%. After the analysis of the data was completed, all of the 10 technology literacy definitions were included in round two.

The participants were asked to evaluate a series of technology skills (round one, part two) on their level of importance to an individual's technology literacy. The participants rated each skill from novice to expert in performing a task to demonstrate technology literacy competency. Participants were asked to pair 22 questions for computer, 21 questions for word-processing, 28 questions for spreadsheet, 19 questions for database, 26 questions for presentations and 17 questions for e-mail communication skills for a total of 133 questions.

In round one, 11 skills out of 132 skills, distributed over all six areas, reached the 80% consensus cut-off level of agreement on their importance to technology literacy (see Table 18). Once the 11 skills were confirmed to reach the 80% consensus cut-off level, they were added to the ATLAS rubric and removed from subsequent surveys. Therefore, 121 skills were included on the round two survey. These skills included 20 computer, 18 word processing, 27 spreadsheet, 18 database, 23 presentation, and 15 e-mail communication skills. To aid participants with each paring of task to skill level a question was posed: A/An (<u>novice, advanced beginner, competent, proficient, expert)</u> user should be able to perform this task. The results for computer, word-processing, spreadsheet, database, presentations and e-mail communication skills are located in Appendix Q.

Table 18. Summary of Skills Meeting Consensus – Round One

Round One Consensus Skills added to ATLAS		
	Skill	Consensus Level 80% and above
Computer Skills		2
	Install and configure new Operating System (OS)	
	Partition a hard Drive	
Word Processing Skills		3
	Create a new document	
	Opening an existing document	
	Add image to document	
Spreadsheet Skills		1
	Create a new document	
Database Skills		1
	Change table view	
Presentation Skills		2
	Create a new presentation	
	Change PowerPoint views	
E-Mail Comm Skills		2

Table 18. Summary of Skills Meeting Consensus – Round One (continued)

	Skill	Consensus Level 80% and above
	Compose a new e-mail	
	Work with Conversation - part of same thread	
Total for 80% and above		11

Round Two Results

The following are the results of the round two of the modified Delphi method study. Participants for round two were the same 10 CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office SME instructors that participated in round one. For the modified Delphi method study, round two responses were used as the basis for the round three instrument. Similar to round one, the technology literacy definitions section asked SME participants to rate each technology literacy definition from excellent to poor. The purpose of round two was to seek greater consensus for technology literacy definitions and technology literacy tasks and associated skill levels. The 10 technology literacy definitions were extracted from the literature verbatim, and similar to the single heuristic evaluation the source of the definitions was not included as to not bias the ratings. As part of the questions, participants were asked to fill in the blank to this question, "I feel this is a/an (excellent, good, fair, poor) example of a technology literacy definition" by selecting one of the choices. Round two did not have any technology literacy definitions meet the 80% cut-off value. Since none of the technology literacy definitions met the

80% cut-off value, all 10 definitions were included in the third and final round (See Appendix R for Modified Delphi Method study – Round Two Results)

After the second round of this modified Delphi method study, no trends started to develop, and no technology literacy definition reached the 80% consensus cut-off level. Of the 10 technology literacy definitions, three or 30% of the technology literacy definitions had responses spread over all four of the levels from excellent to poor. Two of the technology literacy definitions met what would be considered a majority consensus cut-off level of 70%. The technology literacy definitions that met the majority consensus were not the same ones that reached 60% in round one. One of the technology literacy definitions that reached 70% (Good) in round two had a 20% (Excellent), 40% (Good), 40% (Fair) distribution in round one. The other technology literacy definition that reached a majority consensus of 70% (Good) in round two had a 10% (Excellent), 50% (Good), 30% (Fair), 10% (Poor) distribution in round one. In summary, many of responses associated with this modified Delphi method study are inconsistent. A definition that meets or comes close to meeting consensus in one round is redistributed away from consensus in the next round making it difficult to identify any trends/patterns in the data.

For rounds two and three, the consensus cut-off level was changed to majority, which in the modified Delphi method study was 60% and above. This was done due to the low number of skills meeting the 80% consensus level. To illustrate the impact this change had on the study, I will identify the number of skills that met the original 80% and above consensus cut-off level, and then the number of skills that met the majority consensus (60% & 70%) cut-off level. For round two, seven skills from all six areas reached the 80% consensus cut-off level of agreement on their importance to technology literacy. Forty-seven items reached a majority consensus cut-off level, which is 60% and 70%. Once the skills were confirmed to reach the 80% consensus cut-off level, they were added to the ATLAS rubric and removed from subsequent surveys (see Table 19).

Since the majority consensus cut-off level adjustment was made after the modified Delphi method study was complete, the tallying of consensus items was done retroactively. If a skill met the majority consensus cut-off level in rounds two and three, it was considered to have met the majority consensus cut-off level in round two since it met the cut-off in that round first. If a skill met the majority consensus cut-off level in both rounds and had differing skill levels, the level was recorded with the round two skill level. For example, if a skill met the majority consensus cut-off level but was in the novice skill level in round two and in the competent skill level in round three, the novice skill level was recorded, and that task was removed from the survey and placed in the ATLAS under novice. Therefore, 54 skills were added to the ATLAS. These skills included nine from computer, 10 from word processing, 10 from spreadsheet, four from database, 12 from presentation, and nine from e-mail communication skills. Table 19 provides a summary of the skills that met the 80% consensus cut-off level as well as the majority consensus cut-off level.

Table 19. Summary of Skills Meeting Consensus – Round Two

Round Two Consensus Skills added to ATLAS		
	Consensus Level 80% and above	Consensus Level Majority 60% & 70%
Computer Skills	1	8
	Add/remove programs/apps	Select appropriate software program
		Share documents via removable storage devices - i.e. USB keys
		Setup a wireless printer
		Map a network drive
		Restart a frozen/locked up computer
		Enter, change, save BIOS settings
Word Processing Skills	0	10
		Formatting text
		Copy & Paste
		Add a new source for bibliography and create bibliography
		Create a Blog post
		Insert an Online Video
		Insert Page Number and Page Breaks
		Generate a Table of Contents
		Track and review changes
		Lock and Unlock Tracking
		Change line spacing in a paragraph
Spreadsheet Skills	4	6
	Find and open an existing document	Add rows or columns
	Turn on text wrapping	Add cell borders and shading
	Freeze column and row titles	Change height and width of rows and columns
	Change Page Setup options	Error checking and trace error
		Create and use Macros
		Upload to cloud

Table 19. Summary of Skills Meeting Consensus – Round Two (continued)

	Consensus Level 80% and above	Consensus Level Majority 60% & 70%
Database Skills	1	3
	Find and open existing document	Create a new database
		Change font and size
		Move or delete fields
Presentation Skills	0	12
		Insert slides
		Preview a slide show
		Apply a theme
		Insert, size and move clip art
		Move a slide object
		Add sound and video to slides
		Animate objects (tables, charts, clip art, etc..)
		Define slide transitions
		Record narration
		Create speaker notes
		Run a slide show
		Copy presentation to USB or Cloud
E-Mail Comm Skills	1	8
	Send a file attachment	Create a new contact
		Import/export contact list
		Schedule an appointment
		Invite attendees to an appointment
		Work with a to-do bar
		Screen Junk mail
		Create rules for emails
		Link other e-mail accounts to Outlook
Total for 80% and above	7	
Total for Majority (60&70%		47
Total for all skills meeting consensus		54

Round Three Results

The following are the results of the third and final round of the modified Delphi method study. The participants for the third round were the same 10 CAPP 120 Introduction to Computer and CAPP 131 Microsoft Office SME instructors that participated in round two. Similar to round two, the technology literacy definitions section asked SME participants to rate each technology literacy definition from excellent to poor. The purpose of third and final round was to seek final consensus for technology literacy definitions, and technology literacy tasks and associated skill levels. The 10 technology literacy definitions were extracted from the literature verbatim, and similar to the single heuristic evaluation, the source of the definitions was not included as to not bias the ratings. As part of the questions, participants were asked to fill in the blank to this question, "I feel this is a/an (excellent, good, fair, poor) example of a technology literacy definition" by selecting one of the choices (see Appendix S for the results of round three). Round three did not have any technology literacy definitions meet the 80% cut-off value.

After the third and final round of the modified Delphi method study no trends developed, and no technology literacy definition reached the 80% consensus cut-off level. Four technology literacy definition reached the newly adopted majority (60% and above) cut-off consensus level. Of the four, only one reached a consensus higher than 60%. The Q20 technology literacy definition reached 70% in the excellent category making it the only technology literacy definition to be considered exemplary in the modified Delphi method study. The remaining three participants (30%) felt this technology literacy definition was a good example of a technology literacy definition. This technology literacy definition had a distribution of 20% (Excellent), 50% (Good), 30% (Fair) distribution in round one and a 40% (Excellent), 20% (Good), 30% (Fair), 10% (Poor) distribution in round two. The state of New York's (Q20) technology literacy definition was the only one that was identified as being exemplary and is as follows:

> Technology literacy is:
> 1. An understanding of the concepts behind computing equipment, network connectivity, and application software;
> 2. The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and
> 3. The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace.

New York's technology literacy definition is a well-rounded definition that is not bound by an immediate timeframe or specific technology. While the first definition might be more suitable as part of a definition defining digital literacy, it is also well suited to define technology literacy. This definition establishes measurable skills as well as abilities. This definition is also well defined in that each of the numbered items could also be used by itself to define technology literacy. Other definitions have components of this definition but are not as inclusive.

Of the 10 technology literacy definitions, one (10%) of the technology literacy definitions had responses spread over all four of the levels from excellent to poor. This was a drastic change from the 60% in round one responses that were spread over all four of the levels from excellent to poor. This meant that nine of the technology literacy definitions had a redistribution of the responses from being spread over the four levels to being distributed over three. While some spreads did lessen, from four to three, there still were no technology literacy definitions that met the 80% consensus.

In rounds two and three of the modified Delphi method study, SME's continued to pair/match up technological skills with their corresponding skill level. For rounds two and three the consensus cut-off level for the skills sections were changed to majority, which in the modified Delphi method study was 60% and above. To illustrate the impact the change had on the study I identified the number of skills that met the original 80% and above consensus cut-off level and then the number of skills that met the majority consensus (60% & 70%) cut-off level. For round three, five skills from all six areas reached the 80% consensus cut-off level of agreement on their importance to technology literacy. Twenty-three items reached a majority consensus cut-off level, which is 60% and 70%. Once the skills were confirmed to reach consensus cut-off level, they were added to the final ATLAS rubric.

In round three, the participants were asked to evaluate the remaining series of technology skills on their level of importance to an individual's technology literacy. The participants rated each skill from novice to expert in performing a task to demonstrate technology literacy competency. In the third and final round, five skills out of 66 skills, from all six areas reached the 80% consensus cut-off level of agreement on their importance to technology literacy. Once the five skills were confirmed to reach the 80% consensus cut-off level, they were added to the ATLAS rubric. Sixty-six skills from all six areas were included in the final round. The third round included 11 computer, seven word processing, 17 spreadsheet, 14 database, 11 presentation, and six e-mail communication skills. To aid participants with each pairing of task to skill level a question was posed: A/An (novice, advanced beginner, competent, proficient, expert) user should be able to perform this task. The third and final round added 28 skills to the final ATLAS rubric. These skills included five from computer, two from word processing, seven from spreadsheet, three from database, eight from presentation, and three from e-mail communication skills. Table 20 illustrates the skills that met the 80% consensus cut-off level as well as the majority consensus cut-off level.

Table 20. Summary of Skills Meeting Consensus – Round Three

Round Three Consensus Skills added to Final ATLAS		
	Consensus Level 80% and above	Consensus Level Majority 60 & 70%
Computer Skills	1	4
	Copy/Delete a file	Create a program/app shortcut on Desktop
		Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System
		Create/delete a folder
		Connect to Cloud storage
Word Processing Skills	0	2
		Set tabs
		Add header or footer
Spreadsheet Skills	2	5

Table 20. Summary of Skills Meeting Consensus – Round Three (continued)

	Consensus Level 80% and above	Consensus Level Majority 60 & 70%
	Change font and size	Add a worksheet and rename
		Link formulas/functions between worksheets
		Create and use Pivot Tables
		Use fill handle to copy cells
Database Skills	0	3
		Create a new table
		Search for a record using a form
		Enter data into an existing database
Presentation Skills	0	8
		Delete a slide
		Create a photo album presentation
		Change content in a presentation
		Add and Edit a Slide show
		Set line Spacing
		Add text boxes
		Reorganize slides
		Create a self-running slideshow
E-Mail Comm Skills	2	1
	Search for e-mail items or people	Link contacts
	Reply to or forward a message	
Total for 80% and above	5	
Total for Majority (60&70%		23
Total for all skills meeting consensus		28

The purpose of the modified Delphi method study was to identify a/an exemplary technology literacy definition(s) and populate the ATLAS with skills from six areas matched-up with the appropriate skill level. The section of the modified Delphi method study addressing the technology literacy definitions started with 10 technology literacy definitions identified as part of the single heuristic evaluation. Over the course of the three rounds, one technology literacy definition was identified as being exemplary. The technology literacy definition used by the state of New York was identified as the single exemplary technology literacy definition. Seventy percent of the participants identified New York's technology literacy definitions as being an excellent example, and the remaining 30% identified the definition as being good.

The second part of this modified Delphi method study asked participants to pair/match-up skills identified in six areas with their appropriate skill level. The six areas consisted of 131 skills; 22 in computers, 20 in word processing, 28 in spreadsheet, 19 in database, 25 in presentation and 17 in e-mail communication. Of the 131 skills that were part of round one, 120 or 92% of the skills moved forward to be part of round two. Of those 120 skills, 66 or 55% of the skills moved forward to be part of the final round. At the completion of the final round, 38 skills or 29% of the total 131 skills did not meet consensus and were not added to the final ATLAS rubric. Of the skills that did not meet consensus, six skills remain for computer (27%), five skills remain for word processing (25% of the total), nine skills remain for spreadsheet (32%), 11 skills remain for database (58% of the total), three skills remain for presentation (12%), and two skills remain for e-mail communications (12%) (see Table 21).

Table 21. Modified Delphi Method Study Consensus Summary of all Three Rounds

	ATLAS Skills Per Area Per Round									
	Round One		Round Two			Round Three				
	Number of skills	80% and above	Number of skills	80% and above	Majority 60 & 70% Round two	Number of skills	80% and above	Majority 60 & 70% Round three	Total number of skills moved to ATLAS	Total Skills left per area
Computer Skills	22	2	20	1	8	11	1	4	16	6 (27%)
Word Processing Skills	20	3	17	0	10	7	0	2	15	5 (25%)
Spreadsheet Skills	28	1	27	4	6	17	2	5	18	10 (36%)
Database Skills	19	1	18	1	3	14	0	3	8	11 (58%)
Presentation Skills	25	2	23	0	12	11	0	8	22	3 (12%)
E-Mail Comm Skills	17	2	15	1	8	6	2	1	14	3 (18%)
Initial number of skills for all six areas:	131								93 (71%)	38 (29%)
Starting number of skills for subsequent rounds			120			66				
Totals for 80% and above for each round		11		7			5		23 (18%)	
Totals for Majority (60&70%) Round two and three (respectively)					47			23	70 (53%)	
Total number of skills remaining after each round		120			66			38		

Holistic Conclusion – Modified Delphi Method Study

The holistic conclusion for this study was the bringing together the results of research question one and two. These results were the exemplary technology literacy definition and the final ATLAS rubric. The final exemplary technology literacy definition was identified by two step process. First, a heuristic evaluation was conducted reducing 25 technology literacy definitions identified in the literature down to 10. These 10 technology literacy definitions were then added to the modified Delphi method study. After three rounds, participants identified by consensus, a single technology literacy definition that was deemed exemplary. This exemplary definition is New York's technology literacy definition using SETDA's technology literacy definition as a base definition. New York's exemplary technology literacy definition was:

> Technology literacy is:
> 1. An understanding of the concepts behind computing equipment, network connectivity, and application software;
> 2. The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and
> 3. The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace.

In addition to the identification of an exemplary technology literacy definition, the components for the final ATLAS rubric were also identified by consensus.

ATLAS Rubric

Ten technology experts in higher education were asked how they would align academic technology literacy skills with skill levels. These alignments would be used to create an Academic Technology Literacy ASsessment (ATLAS) rubric. This was accomplished using a modified Delphi method study methodology. Over the course of three rounds, the participants were asked to align academic technology literacy skills with skill levels. Over the course of the three rounds, any alignments that met consensus were added to the ATLAS rubric. At the completion of the third round, 93 skills met some level of consensus and were added to the final ATLAS rubric. The final ATLAS was the result of a single, three round modified Delphi method study and should not be seen as a complete, comprehensive rubric. The ATLAS is not meant to be static instrument, but an ever-evolving assessment tool with feedback from users. Table 22 is the final ATLAS rubric.

The National Educational Technology Standards (NETS-S), a sub-section of the International Society for Technology in Education (ISTE), and other organizations like the North Central Regional Educational Laboratory (NCREL), National Research Council, International Technology and Engineering Educators Association (ITEEA) and the National Assessment of Educational Process (NAEP)/ Technology and Engineering Literacy (TEL) have assessment rubrics for assessment procedures and standards in place for assessing technology literacy. In the academic arena, The Association of American Colleges & Universities has developed the Valid Assessment of Learning in Undergraduate Education (VALUE) rubrics as part of their Liberal Education and America's Promise (LEAP) initiative (Association of American Colleges and Universities [AAC&U], 2016). However; these rubric systems have not been widely implemented beyond K-12 (Knight, 2006; Rosenblatt, 2010).

In chapter two, a number of higher education institutions were reviewed as to if they have a mechanism in place to assess technology literacy, and if so how? Very few offered a formal way for students and possibly faculty to assess their technology literacy. Florida Golf Coast (Florida Gulf Coast University, 2017) does have a simple yes/no questionnaire the could be used to assess ones' technology literacy, but it lacks any substantive depth due to its structure of yes/no. There have been other attempts, but those attempts have been general. The ATLAS rubric offers a greater level of self-assessment by providing the skill and skill level. Admittedly, the ATLAS is not without flaws. Similar to the study conducted by Hilberg and Meiselwitz (2008), students as well as faculty could overestimate their technology literacy skill level higher that what they could actually perform if asked to do so.

Today, in higher education, there are very few technology literacy rubric systems that offer students the ability to self-assess their technology literacy levels. Many of the rubric systems listed in a college catalog or on the college's website are used for information literacy assessment and not technology literacy. As students start to use the ATLAS to identify and increase their technology literacy skills (experiential knowledge), students will in turn develop a greater technology literacy. Once the students gain greater technology literacy, they will have the experiential knowledge "to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas" (State Educational Technology Directors Association [SETDA], 2007).

Since the ATLAS is an ever-evolving instrument, feedback from users is vital. The vision for the assessment and maintenance of the ATLAS itself would be done by soliciting feedback from the users, the student and faculty. During the pilot testing phase, the ATLAS would be assessed at the beginning, middle and end of every semester. As the ATLAS moves from the pilot testing phase into more wide-spread usage, the assessment duration could be reduced to once a semester, and then to once a year.

Table 22 Academic Technology Literacy ASsessment – ATLAS

Academic Technology Literacy Assessment – ATLAS					
Skill	**TL-1 Novice**	**TL-2 Advanced Beginner**	**TL-3 Competent**	**TL-4 Proficient**	**TL-5 Expert**
Computer (CMP)	Copy/Delete a file	Select appropriate software program Create a program/app shortcut on Desktop Pin a program/app to Task Bar Create/delete a folder Connect to Cloud storage Share documents via removable storage devices - i.e. USB keys	Add/remove programs/apps Restart a frozen/locked up computer	Install and configure new Operating System (OS) Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System Setup a wireless printer Map a network drive	Partition a hard drive Enter, change, save BIOS settings Design and install an office network

Table 22. Academic Technology Literacy ASsessment – ATLAS (continued)

Skill	**TL-1 Novice**	**TL-2 Advanced Beginner**	**TL-3 Competent**	**TL-4 Proficient**	**TL-5 Expert**
Word Processing (WP)	Create a new document Opening an existing document Formatting text Copy & Paste	Add image to document Set tabs Add header or footer Change line spacing in a paragraph	Add a new source for bibliography and create bibliography Insert an Online Video Track and review changes Lock and Unlock Tracking Insert Page Number and Page Breaks	Generate a Table of Contents Create a Blog post	

Table 22. Academic Technology Literacy ASsessment – ATLAS (continued)

Skill	TL-1 Novice	TL-2 Advanced Beginner	TL-3 Competent	TL-4 Proficient	TL-5 Expert
Spreadsheet (SP)	Create a new document Find and open an existing document Enter data into spreadsheet Change font and size Use fill handle to copy cells	Turn on text wrapping Add rows or columns Add cell borders and shading Change page setup options Enter simple formulas such as MAX, SUM, MIN and AVG Change height and width of rows and columns Add a worksheet and rename	Freeze column and row titles Sort and Filter data Upload to cloud	Link formulas/functions between worksheets Error checking and trace error Create and use Macros	Create and use Pivot Tables

Table 22. Academic Technology Literacy ASsessment – ATLAS (continued)

Skill	TL-1 Novice	TL-2 Advanced Beginner	TL-3 Competent	TL-4 Proficient	TL-5 Expert
Database (DB)	Find and open existing document Create a new database Enter data into an existing database	Change table view Create a new table Search for a record using a form Move or delete fields			

Table 22. Academic Technology Literacy ASsessment – ATLAS (continued)

Skill	TL-1 Novice	TL-2 Advanced Beginner	TL-3 Competent	TL-4 Proficient	TL-5 Expert
Presentation (PR)	Create a new presentation Delete a slide Preview a slide show	Insert slides Change PowerPoint views Create a photo album presentation Move a slide object Apply a theme Run a slide show Add and Edit a Slide show Change content in a presentation Set line Spacing Insert, size and move clip art Add text boxes	Add sound and video to slides Animate objects (tables, charts, clip art, etc.) Define slide transitions Reorganize slides Create speaker notes Create a self-running slideshow Copy presentation to USB or Cloud	Record narration	

Table 22. Academic Technology Literacy ASsessment – ATLAS (continued)

Skill	TL-1 Novice	TL-2 Advanced Beginner	TL-3 Competent	TL-4 Proficient	TL-5 Expert
E-mail Communication (CM)	Compose a new e-mail Reply to or forward a message	Create a new contact Send a file attachment Work with Conversation - part of same thread Include CC and BCC's to an email Search for e-mail items or people	Import/export contact list Link contacts Schedule an appointment Invite attendees to an appointment Work with a to-do bar Screen Junk mail	Create rules for emails Link other e-mail accounts to Outlook	

Integration Questionnaire Results

To address research question three, the integration questionnaire was developed to better understand the needs to integrate the ATLAS at the course, department, college and university level. Seven questions were developed to specifically target certain areas of concern. These areas are: feasibility, policies and procedures, challenges, advantages, opportunities, fiscal and personnel resources, and the value of integration. The seven questions were formatted as open-ended questions providing participants ample opportunity to address the questions. Participants were selected from the university at-large, but not from the universities affiliate campuses.

Participants

Participants for the integration questionnaire were selected using purposive sampling. A participant was selected from each of the course (faculty), the department (department head/chairs), the college (assistant, associate, and deans), and the university (provost's) levels. The criteria for the selection of the type of individual that was sought were as follows:

Course: A faculty member, i.e., Writ 101 instructor

Department: An individual acting in the capacity of an academic Department Head/Chair, i.e., Department Head/Chair of Chemistry

College: An individual acting in the capacity of Assistant Dean, Associate Dean or Dean, i.e., Dean of the College of Arts and Architecture.

University: An individual acting in the capacity of an academic assistant, associate, or provost, i.e., Executive Vice President for Academic Affairs and Provost

Demographics

As part of the integration questionnaire, participants were asked to provided demographic information to identify them, but not to go as far as to personally identify them (see Table 23). The extensive years of higher education teaching experience, coupled with the high level of technology literacy makes all four ideal participants, providing a valuable perspective as to how the ATLAS could be integrated into their respective levels. Of the four integration questionnaire participants, two were male (50.00%), and two were female (50.00%). One of the participants is within the age range of 35-44 (25.00%), two are within the age range of 45-54 (50.00%), and one is within the age range of 65 or older (25.00%). One of the participants hold a master's degree (25.00%), and three of the participants hold a doctorate degree (75.00%). The number of years participants have been working in higher education vary. One participant has been working in higher education 5-10 years (25.00%), one participant has 10-15 years (25.00%) of experience in higher education, one participant has 15-20 years (25.00%) of experience in higher education, and one participant has 20-25 years (25.00%) of experience in higher education.

Table 23. Characteristics of Participants – Integration Questionnaire (N = 4)

Demographic	*N*	%
Gender		
Male	2	50.00
Female	2	50.00
Age range		
Under 18	0	0.00
18 – 24	0	0.00
25 – 34	0	0.00
35 – 44	1	25.00
45 – 54	2	50.00
55 – 64	0	0.00
65 or older	1	25.00
Highest degree or level of school completed		
Less than a high school diploma	0	0.00
High school degree or equivalent (e.g. GED)	0	0.00
Some college, no degree	0	0.00
Associate degree (e.g. AA, AS)	0	0.00
Bachelor’s degree (e.g. BA, BS)	0	0.00
Master’s degree (e.g. MA, MS, MEd)	1	25.00
Professional degree (e.g. MD, DDS, DVM)	0	0.00
Doctorate (e.g. PhD, EdD)	3	75.00
Title of current position		
Faculty - Any rank	1	25.00
Department Chair/Head	1	25.00
Assistant Dean, Associate Dean or Dean	1	25.00
Assistant Vice President or above	0	0.00
Other	1	25.00
Number of years working in Higher Education		
1-5	0	0.00
5-10	1	25.00
10-15	1	25.00
15-20	1	25.00
20-25	1	25.00
Over 25	0	0.00

Results

The integration questionnaire was the last group of data collected. The purpose of the integration questionnaire was to explore what steps would need to be taken to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, department, college and university level. This was accomplished by asking four participants, one from each area, seven questions associated with integration or sometimes referred to the institutionalizing of a program/initiative. The following were the results of the integration questionnaire data collection.

The integration questionnaire and integrated informed consent form were individually sent to the four that agreed to participate. The integration questionnaire asked participants the same informed consent, demographic and seven integration questions except for the use of different respective identifiers in each question. The different respective identifiers were, for example, how feasible do you feel the integration of the ATLAS within your/the (course, department, college and university) as a whole. For example, the word university was replaced with the respective identifier of: course, department, college and university. This was done for each of the seven questions.

The responses from the integration questionnaires for the four areas (course, department, college and university) were then analyzed. From the seven integration questions, seven categories were identified. The seven emerging categories were: feasibility, governance (policies and procedures), challenges, advantages, opportunities, resources (financial and personnel), and value. Tables were then created with each category and the associated responses from each of the four participant's areas associated with their respective categories. A content analysis was conducted resulting in one grand theme for all of the responses, this grand theme is starting point. Table 24 is the verbatim responses from all four participants for the first category: feasibility. This question asked participants how feasible it would be to integrate the ATLAS at each of their respective levels. Except for the university level, all felt that the integration of the ATLAS was feasible to highly feasible. With a university of 16,000 plus students, it is understandable how it would not be feasible to integrate the ATLAS university wide. Three of the participants feel the ATLAS can feasibly be integrated. Feasible means that something is possible, achievable, practical, all of which need a starting point. For the course participant, they see a starting point for integration of the ATLAS by just adding the ATLAS even though some of the classes may not need the assessment areas like spreadsheets or database knowledge.

Table 24. Integration Questionnaire Responses for Feasibility

Level	How feasible do you feel the integration of the ATLAS within the university as a whole?
Course	I think it would be feasible. The courses I am currently teaching would not have a strong need for spreadsheet or data base knowledge, but it would be easy to just put TL-1 for those areas.
Department	I think it is highly feasible. I would be interested in what testing you used to create the rubric. Specifically, what was your process to identify which skills within the "computer" designation were selected to be "novice" compared to those that were "competent".
College	Feasible.
University	Not feasible.

Table 25 organizes the participant verbatim responses to governance, where participants were asked to explain any policies and procedures within their respective areas that would need to be adhered to in order for the ATLAS to be integrated. While no specific policies and procedures were identified, participants did explain that the use of the ATLAS would be voluntary. It was also expressed that there would need to be some educational awareness within the college as to the importance of technology literacy to all those within the college. New policies and procedures would need to be created at the university level due to the scale of the integration. This creation of new policies and procedures would be a starting point. A starting point for the course level, the ATLAS integration “could provide a baseline for those entering the course” (see Table 25 for complete response from course participant). A starting point for the faculty within a department could be the optional use of the ATLAS as part of their syllabi. The governance starting point for a college would be bringing everyone together to start the conversation of “the importance of technological literacy” in the college is and the importance of the ATLAS as an assessment tool. The university participant identified that new policies and procedures would need to be created, all of which are starting points.

Table 25. Integration Questionnaire Responses for Governance (policies and procedures)

Level	What policies and procedures would need to be adhered to in order to integrate the ATLAS within one of your courses?
Course	Do you mean university policies and procedures? I think I would still have to let students take my course who had limited technological proficiency. So I could not use ATLAS to prevent someone from taking my course. This would be different in a course that was primarily technology based (e.g., design). However, it could provide a baseline for those entering the course.
Department	This would be an optional component that faculty could choose to add to their syllabi or other course welcome materials.
College	I think we would need to convene the directors, dean and curriculum committees (maybe all faculty) to describe the ATLAS and inform them of the importance of technological literacy in our college and why this is an important assessment tool and a way to determine our students prior knowledge.
University	We would need to create new policies and procedures.

Participants were asked to explain the challenges they foresee their colleagues in their respective areas facing with the integration of the ATLAS. Table 26 is the verbatim responses from all four participants for the third category: challenges. This category split into two themes, personal securities/insecurities and time. Personal securities/insecurities surfaced as a theme in terms of students as well as faculty feeling intimidated and unsure of themselves because of their own level of technology literacy or illiteracy. In order to integrate the ATLAS at the university level, a great deal of time would need to be invested by all levels, from the faculty to the senior level administrators. The integration of the ATLAS may not be as high on the priority list as another initiatives, so their allocation of time would be less for the ATLAS integration.

Table 26. Integration Questionnaire Responses for Challenges

Level	What challenges do you foresee with integrating the ATLAS within the university as a whole?
Course	I wonder if students might be deterred from taking the course if there is a higher ATLAS rating (e.g., they could underrate their own knowledge). They may be capable, but are intimated because they think others have a stronger knowledge in the areas. I could see this (from my experience) being especially true for non-traditional students. Another challenge may be that I offer assignment choices in my class. Some of the assignment choices would require a higher TL in some areas -- so for my course one TL for each area would not be completely accurate and setting a higher TL may prevent some students from taking it when they could do fine (based on their assignment choice) in the class with a lower TL.
Department	I think faculty would struggle to identify which level to specify. I can envision greater adoption if they were able to "check off" the specific skills within a specific domain (like computer) a student would need competence.
College	The biggest challenges will be around faculty feeling technology illiterate and unsure if they are qualified to be part of this or have it in their unit.
University	Time would be the major challenge. Other priorities would be the second. Faculty, department heads, deans want to be involved in the design of new requirements and would need to help write rubrics. Faculty and department heads have other needs that may be more pressing. For example, assessment of curriculum and programs for accreditation may receive more attention from administration. We would not require the use of ATLAS rubrics but could make them optional for departments/programs to develop and may be more popular for some disciplines than others.

At the opposite end of the spectrum, participants were asked what advantage they foresee with the integration of the ATLAS within their respective levels. Table 27 is the verbatim responses from all four participants for the fourth category: advantages. A common theme was that the integration of the ATLAS would aid student and faculty evaluate their preparedness for a class. The ATLAS could also help facilitate conversations between students and faculty on the association of what they are learning, their technology literacy and the interrelationship of academics and industry. The college participant pointed out that it is assumed that students falling into the category of traditional age, they are versed with technology, hence being technology literate. This has been observed by this participant to not necessarily be the case. An advantage of the ATLAS could be its use as a quality assurance tool by the academic community. For example, an instructor teaching sequential business courses could use the ATLAS to scaffold the spreadsheet skills needed for each of the sequential courses. This list of scaffolded skills could be attached to the course descriptions (for example, TL-SP1, TL-SP2), or as part of the syllabi. Students would know the required TL-SP skills required for each of the sequential business classes up front.

Table 27. Integration Questionnaire Responses for Advantages

Level	What advantages do you foresee with integrating the ATLAS within one of your courses?
Course	ATLAS could be another point for students to evaluate their preparedness for the class. It may also help them realize why they might be struggling in a class and they could figure out areas they could enhance their technological knowledge. ATLAS could also be introduced in a freshmen course to make sure that students have these skills.
Department	It would be valuable to share with students which technological skills they will be required to have (or develop) for a course. Students are beginning to ask whether their coursework and approach to learning is relevant to the work world. It would be helpful for faculty to think through how they use technology and what level of proficiency and competence they expect of students.
College	I think we assume our students have technology literacy because of their age, but our students are often less literate than we are, especially with the advent of touchscreen apps. It is important we understand what it means to be technology literate and this could serve as a quality assurance tool for faculty, staff and students alike.
University	Students would know what skills are needed for a course and faculty would know the technology entry level of students.

The opportunities question was viewed different from advantages, in that opportunities of the ATLAS would be seen as, what would the integration allow for that is not currently in place – possibilities that currently do not exist. Table 28 is the verbatim responses from all four participants for the fifth category: opportunities. Much like feasibility, opportunities can be seen as starting points. This question allowed the participants to “think outside the box” of how the ATLAS could facilitate opportunities. For example, a course level faculty could use the ATLAS as a formal way of not only identifying skills needed, but also illustrate the academic career benefits. The participant for the college sees the ATLAS providing an opportunity for the faculty to facilitate their discovery of their own technology literacy strengths and weakness. With this discovery, faculty could identify an action plan as to how they could diminish their weaknesses. Students would also use this same process and is at the center of what the creation of the ATLAS is all about.

Table 28. Integration Questionnaire Responses for Opportunities

Level	What opportunities do you foresee with integrating the ATLAS within one of your courses?
Course	I could see some of my courses that are research intensive benefiting from ATLAS. Formatting papers (references; headings, running heads) always seem to be a problem. ATLAS could be a formal way of helping students know they need this skill.
Department	Again, I don't see the utility of ATLAS in its rubric fashion. I think its greatest opportunity is for faculty to "check off" the technological skills needed for success in the course.
College	Interesting, I think the same as the last question. But to add to it, this is an opportunity for us to determine our own levels of technology literacy and an opportunity to improve our abilities.
University	Students would know what technology skills are needed for a course, know what gaps they have, and therefore be able reduce the gaps and come to class better prepared to be successful.

The resources category (see Table 29) focused on developing a better understanding of the foreseeable financial and personnel needs for the integration of the ATLAS. Table 29 is the verbatim responses from all four participants for the sixth category: resources. The needs for additional resources for each of the areas can be associated with each area increase as the size of the level increases. The cost of integration at the course level will be far less than at the university level. This cost for the levels beyond the course level will be, to a certain extent, dictated by the amount of resources within the area that are currently available in the forms of fiscal and knowledge capital.

Table 29. Integration Questionnaire Responses for Resources (financial and personnel)

Level	Do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within one of your courses?
Course	I think it wouldn't be too challenging for me personally. However, some of my colleagues would struggle. They would need someone to train them and would probably like assistance in implementing it in their course.
Department	No
College	I think some training will have to come with rolling it out and then maybe access to help, similar to Brightspace help, as people forget how to integrate details of the Atlas or as new faculty are hired.
University	Yes - adding personal costs money. A graduate student in each department could perhaps work with the faculty in a department to create this - but they too cost money.

The last category is value. Participants were asked what value they would place on the integration of the ATLAS. Would the integration of the ATLAS make a difference to the academic community? Table 30 is the verbatim responses from all four participants for the seventh, and final category: value. All the participants feel there is value associated with the integration of the ATLAS, but it may be difficult to do at large scale level such as the university as a whole. Value would also come from the use of the ATLAS as a diagnostic tool for faculty to self-assess their technology literacy. Value would also come in the form of standardization of increasing technology literacy expectations.

Table 30. Integration Questionnaire Responses for Value

Level	What value would you place on the integration of the ATLAS within one of your courses?
Course	It could be most helpful in my uppder division course offerings when there are greater technology expectations. I think standardizing TL could be helpful across programs.
Department	I think the value is in thinking through the different domains of technological skills required in our courses (Computer, Database, Spreadsheet, Presentation, etc.) and the specific skills associated with each. I think it could be a valuable diagnostic tool for faculty to self-assess their own technological competence along with helping them to position their course in terms of its technology expectations accordingly.
College	I think it would be very valuable.
University	This would be valuable but difficult to integrate within the university.

Chapter Four Summary

Chapter four presented the results of the four data collection instruments. To orientate the readers, the purpose of the study, research questions and methodology was restated. The heuristic evaluation results were presented first including overview of the participants, their demographics concluding with the responses they provided. This same format was used to present the result for the pilot study, modified Delphi method study and the integration questionnaire. For the integration questionnaire, the grand theme of the starting point, threaded the categories together by identifying that each of them needed a starting point and the ATLAS could provide this starting point.

CHAPTER FIVE

DISCUSSION

Introduction

The purpose of this modified Delphi method study was to address three research questions. This process was completed in three stages. The first stage was to identify exemplary technology literacy definitions from current technology literacy definitions identified in the literature from 1991 to 2015. The second stage, and center of this study was the development of the ATLAS rubric. The final stage of this study was to identify steps needed to implement the ATLAS at the course, department, college and university level. For this study, a focus on technology literacy provided broader skills selection and the application for the ATLAS.

Summary of the Study

Chapter one provided an overview and the background of the study by bringing forward the conversations of national technology literacy initiatives, technology literacy, assessment and rubrics, each are key components of the ATLAS rubrics. Other key components of chapter one were the statement of the problem, purpose of the study, research questions, significance of the study, overview of the research design and how the ATLAS construct was framed. Chapter two started by discussing how the theories of knowledge, more specifically levels of knowledge, experiential knowledge, Knowledge, Skill and Abilities (KSA) and Attitude, Skill, and Knowledge (ASK), student demographics, definitions (digital, information and technology), rubric systems and a historical development of the Delphi method. Chapter three covered the methodology for this study. Restated in that chapter was the research questions. The rationale for the chosen research design was also discussed as well as my positionality and reflexivity within the research. The research setting, and population were covered in general. Following that section, each of the four data collection methods were discussed; the single heuristic evaluation, the pilot study of the modified Delphi methods study, the modified Delphi method study and the integration questionnaire. With four separate data collection instruments, the sample, sampling method and size, instrument, data collection, analysis and outcome were covered as a group with their respective method. The timeline for the data collection, research validity and chapter summary concluded chapter three. Chapter four presented the results of the four data collection instruments. To orientate the readers, the purpose of the study, research questions and methodology was restated. The single heuristic evaluation results were presented first including a brief overview of the participants, their demographics and concluded with the responses they provided. The same format was used to present the result for the pilot study, modified Delphi method study and the integration questionnaire. Chapter five brought this study to a close with an introduction to the chapter, which included the restatement of the purpose and significance of the study, and a summary of the study. Following the summary of the study, the research questions are restated, and then each research question is discussed highlighting the major findings and how the findings addressed the associated research question. The outcome of the study was discussed in the holistic conclusion section where the ATLAS rubric was presented. In the applications/implications of the study results section, an overview of the applications of the ATLAS were discussed. The limitations section addressed shortcoming of the study that only surfaced after the data collection and analysis phase of the study was complete. The recommendations for future research reflected the findings and limitations to recommend future alterations to this study, or completely new studies that could spawn from this study. The conclusion section brings chapter five, and the study as a whole, to a close by summarizing the final chapter and the study as a whole.

Research Questions

The primary objectives of this modified Delphi method study were to gain a better understanding of the technology literacy construct by identifying exemplary definitions from current technology literacy definitions, create a Academic Technology Literacy Assessment (ATLAS) rubric, and identify steps to integrate the rubric at the course, department, college and university level. The following three research questions directed this modified Delphi method study.

RQ1: How do technology experts in higher education define technology literacy?

RQ2: How do technology experts in higher education align academic technology literacy skills with skill levels to create an Academic Technology Literacy ASsessment (ATLAS) rubric?

RQ3: What steps would need to be taken to integrate the Academic Technology Literacy ASsessment (ATLAS) rubric at the course, program, department, college and university level?

Research Question One

The objective of research question one was to gain a better understanding of the current technology literacy definitions, and more specifically, identify exemplary examples. This would be done with the use of two data collection methods, a single heuristic evaluation and a modified Delphi method study. The single heuristic evaluation was addressed under the research question one section, the modified Delphi method study was addressed under the research question two section. The single heuristic evaluation was used to reduce 25 technology literacy definitions identified in the literature from 1991 thru 2015 down to 10. After the data collection was complete, an additional 12 technology literacy definitions were identified in the literature from 1978 thru 1989. These additional technology literacy definitions were identified after all data collection for this study was complete. The 12 technology literacy definitions are located in Appendix U These additional 12 technology literacy definitions were mentioned to acknowledge their existence and possible inclusion in future research. Once the 25 technology literacy definitions were reduced to 10, they became the first part of the modified Delphi method study. The findings that addressed research question one was identified as part of the results of the modified Delphi method study – round three. This was where an exemplary technology literacy definition was identified.

Single Heuristic Evaluation. To recap, a heuristic is “an informal method of usability analysis where some evaluators are presented with an interface design and asked to comment on it” (Nielsen & Molich, 1990 ,p. 249). Three participants were recruited to participate in the heuristic evaluation. Scoring the definitions was based on three heuristics with a score of one per heuristic for a maximum Heuristic Evaluation (HE) score of nine for a single technology literacy definition. The participants were also given an option that the definition did not meet any of the heuristic criteria. The top 10 technology definitions were a mixture of single authors defining technology literacy and federal, state and individual organizations defining technology literacy. One of these organizations, The State Educational Technology Directors Association (SETDA), published a report that included how each of the 50 states defined technology literacy. Eight states based their technology literacy definitions in part, or in whole, from the SETDA definition. Included in this report was SETDA's own definition of technology literacy. SETDA defines technology literacy was:

> " the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century" (State Educational Technology Directors Association [SETDA], 2007, p. 1).

The SETDA technology definition received a HE score of two. Two other technology literacy definitions used SETDA's definition almost verbatim as a basis for theirs, one was a state organization and the other was one was a state. Interestingly, these two technology literacy definitions received much higher HE scores.

Colorado's Department of Education (CDE) defined technology literacy as:

> "the ability to responsibly use appropriate technology to:
> - Communicate
> - Solve problems
> - Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas
> - Acquire lifelong knowledge and skills in the 21st century" (Colorado Department of Education, 2009)

Except for a few words that have been removed, the Colorado's Department of Education technology literacy definition was identical to SETDA's technology literacy definition. The key difference between these two technology literacy definitions was the two (CDE & New York) that were presented in bullet form, received higher HE scores than the base SETDA paragraph form that had a HE score of two. The participants of the single heuristic evaluation seemed to gravitate towards a more visual presentation, like the two definitions presented in bullet form. The CDE's HE score for their technology literacy definition was a five. The visual presentation of data seemed to be a theme, the state of New York also used the SETDA technology literacy definition as a base for their definition. New York's definition was not as verbatim as CDE's but the majority of New York's technology literacy definition is SETDA's base definition. With the aid of SETDA's base definition, New York defines technology literacy was:

> Technology literacy is:
> 1. An understanding of the concepts behind computing equipment, network connectivity, and application software;
> 2. The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and
> 3. The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace.

New York's HE score was a six, along with two others, and only one other definition had a HE score higher than six for a total of four technology literacy definitions scoring six and higher. Of the 25 technology literacy definitions presented for heuristic evaluation, CDE and New York's technology literacy definition were the only two definitions visually presented in a different format other than the standard sentence/paragraph structure. What makes this significant was the SETDA base definition that the CDE and New York technology literacy definitions were developed from had a HE score of two. This suggested that the format in which information was presented played a role in how the information was scored. Definitions that were formatted in bullet form were better received by the participants. Based on my experience in the technical communication field, items placed in a list form, such as items that are bulleted, grab readers attention and readers typically gravitate toward something that is easier to read. Ultimately the goal was to move 10 technology literacy definitions forward to the modified Delphi method study to identify an exemplary definition. The technology literacy definitions that were chosen for the original 25 definition list were not chosen for processes or skills specifically as both as covered, in part, in all of the definitions.

Research Question Two

Research question two addressed how technology experts in higher education aligned academic technology literacy skills with skill levels to create an Academic Technology Literacy Assessment (ATLAS) rubric. This was accomplished using a modified Delphi method study methodology. A Delphi/modified Delphi method study was primarily a “structured communication” (Linstone & Turoff, 1975, p.3). This structured communication typically consists of three rounds of information gathering to build a consensus related to a topic. This type of research method typically utilized both qualitative and quantitative methods (Fish & Busby, 1996; Gay et al., 2011; Norman, 1969). At the heart of any Delphi study was the selection of participants that are experts in their respective fields related to the target issue (N. Dalkey & Helmer, 1963; Fish & Busby, 1996; Helmer & Rescher, 1959; C.-C. Hsu & Sandford, 2010; Keeney et al., 2011; Linstone & Turoff, 1975; Rauch, 1979; Skulmoski et al., 2007). These Subject Matter Experts, commonly known as SME's, "contribute their knowledge and experience in order to solve a problem or to answer certain questions" (Rauch, 1979, p. 160). The 10 SME participants for this study were invited to participate from the fall 2017 and spring semester 2018 cohort of instructors teaching CAPP 120 – Introduction to Computers and CAPP 131 – Microsoft Office. Of the 10 SME's, nine (90%) of the SME participants that participated in this modified Delphi method study rated their overall technology literacy/knowledge at (digital and non-digital) either proficient or expert.

For this modified Delphi method study, sections one and two, for all three rounds, collected quantitative descriptive information in the form of percentages for consensus of exemplary technology literacy definitions and ATLAS skills. An effect that was not present, but has the potential to threaten Delphi studies, is what is known as the Bandwagon Effect. The bandwagon effect shows up after round one as a result of participants reading the responses from round one. The bandwagon effect is when for participants join or select the popular option, trend or majority opinion (Hallowell & Gambatese, 2010; Hasson & Keeney, 2011; Helmer, 1967; Helmer & Rescher, 1959; Linstone & Turoff, 1975; Mulgrave & Ducanis, 1975; Ogbeifun, Agwa-Ejon, Mbohwa, & Pretorius, 2016; Pollard & Pollard, 2004; Zimmermann, Darkow, & Heiko, 2012). This study demonstrated the opposite; for example, as part of the computer skills section question four had a consensus of 60% that a person with novice skills would be able to create a program/app shortcut on the Desktop. The consensus was split, with 60% of participants reporting those with novice computer skills and 40% reporting those with competent (two levels beyond novice) computer skills would be able to handle this task. If the bandwagon effect influenced this question, the consensus level for round two would be above 60% because the 40% respondents would join the popular option, trend or majority opinion. This was not the case, in fact the opposite happened. The 60% consensus dissolved to a breakdown of 10% novice, 40% advanced beginner, 40% competent and 10% proficient for round two.

For round three, a skill did return to a majority consensus of 60% but not for the novice skill first reached in round one. For this last round the 60% of the participants felt that an advanced beginner would be able to create a program/app shortcut on the Desktop instead of the novice majority consensus in round one. In round three the remaining percentages were distributed instead of all being registered with a single skill. Only 10% now felt that a novice would be able to create a program/app shortcut on the Desktop, a sharp contrast from the 60% in round one. The other percentages were distributed with 20% going to competent and 10% going to proficient. This skill was not the only skill in which this extreme percentage re-distribution occurred. An interesting characteristic of this study was that over the course of all three rounds, there was no development of the bandwagon effect.

At the conclusion of round three, 93 skills met some level of consensus. The area with the lowest number of skills reaching consensus was database skills with a total of eight skills. This is due in part to database software being the least used software of the six skills used in the study. The area with the highest number of skills reaching consensus was presentations skills with a total of 22 skills. Database skills reached the lowest number of skills meeting consensus. Understanding database skills, I would also be less able to identify database skill levels due to my overall unfamiliarity with the software. Reviewing the data, technology literacy skills for people in the work place versus those in high education, differs only slightly. For example, website design and creation were considered a high value skill for people in the work place versus a low value skill for people in college. A word processing skill that industry felt was highly valued was the ability to sort lists alphabetically, while it was considered a low value skill in higher education classrooms. Another skill that was highly valued by industry, but considered a low value skill by higher education, was the ability to save documents in different formats such as a RTF or PDF (C. L. Smith, 2015).

Many of the students entering higher education classrooms will have many of the skills identified as part of the ATLAS, but many will not. All students at some point in their academic career will experience varying degrees of cognitive load. Paas, Tuovinen, Tabbers, and Van Gerven (2003, p. 64), defined cognitive load as "multidimensional construct representing the load that performing a particular task imposes on the learner's cognitive system." Cognitive load was divided into two primary areas, working memory, and long-term memory (Artino, 2008; Moos, 2013; Paas et al., 2003; W. Roberts, 2017). Working memory was also known as short-term memory. Working memory had a very short cognitive life (15-30 seconds) if not committed to long-term memory by some sort of action that used that information (Artino, 2008). For example, someone telling you how to ride a bike would not be enough to commit the information from working memory to long-term memory without the action of physically using that information to ride a bike. Cognitive overload happens when “excessive demands made on the cognitive processes, especially memory” (W. Roberts, 2017, p. 405). During the first days of class, learning the primary course material brings most students to the edge of their working memory. The addition of learning new technology that they thought, or perceived they already understood, to be successful in their courses has pushed many of them to cognitive overload. These students may simply lack the requisite technology literacy knowledge to successfully navigate their new environment (Moos, 2013), and balance that cognitive load. The ATLAS could help students handle the varying levels of cognitive overload by the self-assessment. Cognitive load theory is a large construct to address fully in this study; therefore, a recommendation to further the conversation of cognitive load and use of the ATLAS connection could be explored. This is suggested as a recommendation for further research later in this chapter.

The student demographics identified in chapter two could benefit greatly by using the ATLAS. As identified in chapter two, the life/learning demographic has an acceptable level of experiential knowledge when it comes to their life technology literacy. This life technology literacy means they are well versed in the use of social media. Waycott et al. (2010) suggests that college students, as well as faculty, use their life and learning technology literacy much differently. The students and faculty were more fluid with life than with their learning technology literacy. This is simply because of the amount of time using the life applications versus the amount of time using learning applications. The life/learning demographic could benefit by using the ATLAS to identify the learning applications (skills) they feel uncomfortable using.

The ATLAS could also be of great benefit to the digital native/digital immigrant demographics. The digital native/digital immigrant demographics are complex in that some students linked to the digital immigrant construct, simply by age, are well versed with technology. This also may hold true for the digital native student being linked to the digital native construct, simply by age, are not versed with technology. Helsper and Eynon (2010) suggest the digital immigrants may find themselves needing a formal class to introduce them to the unknown digital technology that surrounds them. The digital immigrants could use the ATLAS to identify these formal classes. A study by Hilberg and Meiselwitz (2008), taken by students, showed that 73% of the participants overestimated their technology literacy. This overestimation of ones' technology literacy skills is highly likely by both digital natives and digital immigrants.

Paralleling the Hilberg and Meiselwitz (2008) study of student overestimation of their ICT/technology literacy skill, Dednam (2009) conducted a longitudinal survey from 2002 to 2008 looking at how fluent students were with software packages such as Word, Excel, PowerPoint, Access and email communication. From 2002 to 2007, 10,360 students participated in the study with an average of 79% of the students who participated in the study, testing their basic computer/technology literacy, not passing the test. The last year of the study (2008) 2,245 students participated in the study with 83% not passing the basic computer/technology literacy assessment test. While the demographics were not disclosed for these studies, a fair assumption could be made that both digital native as well as digital immigrants made up the demographics of the study.

The last demographic identified in chapter two was the technophobe. As noted in chapter two, technophobia can be so severe that a student will choose courses and subsequently a career that is void of any technology (M. Jensen et al., 2002). The ATLAS would benefit a technophobe in identifying, before they enter a course, whether or not they will be successful and possibly alleviate their discomfort level with technology and allow them to remain in the course.

Research Question Three

Interpreting the findings from research question three in this study requires an elementary understanding of organizational change. Research question three aims to understand what steps would be needed and taken to implement the ATLAS rubric at the course, department, college and university level. Researchers have defined Organizational Change Theory in many ways. Barnett and Carroll (1995) define organizational change as "a transformation of an organization between two points in time." (p. 219). Zorn, Christensen, and Cheney (1999) define organizational change as "any alteration or modification of organizational structures or processes" (p. 10).

An Organizational Change Theory scholar suggested that change is necessary (Kezar, 2014). Change, however, can be viewed as difficult by the end-users as they are often not part of the planning and defining of the proposed change, only the recipients of the directive that must be implemented. This level of change can be difficult to adapt to and integrate.

The ATLAS could be grassroots, bottom-up course level integration, or the top-down provost level integration. To illustrate this organizational change dynamic of bottom-up/top-down change, an analogy of planting a single seed (bottom-up) versus transplanting a mature plant (top-down). The planting of a single seed (bottom up) will be illustrated first.

Environment plays a key factor in the success of a single seed making it to maturity. Once the single seed has been sewn, it takes very few resources (a little sun, water, and nutrients from the environment) to start to germinate. As the single seed starts to mature, the available resources will increase with the plant providing the right amount of nutrients to keep the plant growing. Provided the proper environment and adequate resources, the single seed could become stable without taxing the resource and the environment of neighboring seeds, controlling external forces. The planting of a single seed analogy for grassroots/bottom-up organizational change illustrates that a single initiative, the ATLAS in this case, (seed) incorporated into a single course would require few resources and produce very little negative environmental impact. The instructor integrates ATLAS willingly with only the students of that course being impacted by the integration. With the course/environment being small, the instructor can work closely with students to understand their reasoning for resisting the initiative and control external resisting forces. Provided the proper environment and adequate resources, the initiative becomes stable without taxing the resource and the environment of neighboring courses. Once the initiative (seed) becomes an accepted part of the course, the initiative is proven to work and can be replicated in another receptive course. Change that involves minor improvements and adjustments is considered a first order change (Kezar, 2014). The planting of the single seed requires minor adjustments to the environment with impact only being felt by the immediate surrounding environment. This would be similar to the ATLAS being integrated into a single class.

Similar to the single seed/course, the environment/institution plays a key factor to success. Organizational change shows how a system, whether it be industry or education is initially structured then grows and adapts to our ever-changing demographic and economic world. The basic structure changes little through generations. Education follows industry in that there is a primary leader, a substructure of administration with an equal level substructure of the faculty. The substructure then become the level of faculty and staff which can change more rapidly to the needs of students and industry. This third level is where change such as the grassroots initiative above would do well as a pilot within the university. As change can be complicated through educational and political processes, a grassroots effort with a small group of five to 10 faculty members in courses requiring technology literacy would be a great pilot. Classes requiring technology literacy of each level could implement this rubric in their portion of the Schedule of Classes and would give students and other faculty a chance to see the rubric implemented. From there other faculty, and possible whole departments, could choose whether to add the technology literacy designation to classes within their discipline. Knowing the technology literacy designation would benefit the student in knowing at which level they need to be and benefit the faculty member as they can start right off in class with instruction and not remedial technology literacy review

One organizational change theorist even question where organizational change is possible. Do organizations change or do they merely evolve naturally to environmental factors? Demers suggests the bottom-up change as being a force for change instead of a top-down change being a forced change (Demers, 2007). One way to better understand bottom-up change is to consider it analogous to planting a single seed (bottom-up) versus transplanting a mature plant (top-down). Transplanting (top-down change) a plant (initiative) from another location with a different environment is risky. Bringing a plant that is already mature to a new environment (university/college) takes a large commitment of resource to not only help settle it into the new location but also maintain it until it is established in the new environment. The largest threat to the plant not thriving in the new environment would be the new environment rejecting the plant. Another danger of transplanting is the amount of resources required to stabilize the plant in the new environment that it starts to draw resources from other plants causing them to become vulnerable because of the diminishing of resources. Timing is another risk for transplanting. Transplanting the plant into the environment too early or too late will also cause the plant to be rejected by the new environment.

The transplanting of a plant analogy illustrates that an initiative incorporated into an organization requires a great deal of resources that may or may not be available. If the resources are not available, they will need to come from somewhere else within the organization. As with the plant, bringing in an initiative into a new environment without proper conditioning of the environment to the new initiative more times than not causes the people within this new environment to resist or completely reject it. The change that would be associated with the transplanting of a plant is second-order change. While second-order change is most closely associated with cultural and cognitive theories, it can also be associated with the transplant analogy. Second-order change is where culture assumptions, structures, processes, and underlying values need to be addressed in order for change to happen (Kezar, 2014). For change/change initiatives to happen at the department, college, and university level, change would need to happen at multiple levels requiring greater time and energy (Kezar, 2014). Studies conducted over the past 50 years looking at change initiatives identified a failure rate as high as 90%, with the average being 70%. The primary contributor to the high failure rates was a resistant organizational culture (Argyris, 2004; Beer & Nohria, 2000; Burke, 2017; Greiner, 1967; Hughes, 2011; Kee & Newcomer, 2008; Maurer, 2010).

In the analogy above, change is illustrated bi-directionally as bottom up and top down, but there is often a third; students can initiate change as well. Students are demanding more of their educational institutions regarding technology (Kezar, 2014). Educational institutions know that technology, and helping their students and faculty become more technologically literate, is important, but due to cost, was often seen as something that has to be implemented to remain competitive. Students see faculty's lack of technology literacy as a growing barrier for technology integration in the classrom (Bates & Sangra, 2011). At Virgina Tech, implemented an innovative method to help faculty increase and maintain their technology liteacy. On a revolving schedule, faculty receive a new computer every three year, but in order for the faculty to receive their computer they must attend a half day workshop on how they could use this new technology in their classrooms. Using this innovative method, Virginia Tech managed to have 96% of their faculty participate in instructional development workshops (Bates & Sangra, 2011).

Kezar (2014) suggests that change can happen at the administrative level, but also within other levels that have been given the latitude to facilitate change. The lower level at which integration may take place will also be the level at which updates to the ATLAS rubric may be requested and integrated.

The seven emerging categories identified in chapter four (feasibility, governance, challenges, advantages, opportunities, resources, and value) played varying roles of organizational change within the four areas surveyed in this study. The feasibility for the integration of the ATLAS at the course, department and possibly the college level may have very little impact to the organization as a whole. At the other end of the spectrum, the participant representing the university level responded that the integration of the ATLAS at the university level would not be feasible. This was understandable that the integration of the ATLAS from a top-down was simply due to the number of people that would be involved. Another consideration was the ATLAS may not be applicable to all academic areas at the university level. A successful integration of the ATLAS depends on students' and faculty understanding the purpose of the ATLAS and welcoming the integration at their level. A "have to use" administrative forcing the use would not be welcomed by any faculty.

If the ATLAS was to be integrated at the university level, additional policies and procedures may need to be created to assure consistency of the use by those choosing to integrate the ATLAS. At the course, department and college level, wording in the syllabi for the courses, or on the department and college website might be the only level of governance besides being voted in by the department and college faculty for optional use.

All four participants expressed concern, and also opportunity, the ATLAS would bring in the area of personal self-assessment of technology literacy. Prensky (2001) proclaimed that everyone was either a digital native or a digital immigrant. The native was versed with the use of the technology from a very young age, while the immigrant was "thrown into the deep end" in the sense of using the technology of the time. While it has been over a decade since Prensky's digital native, digital immigrant conversation surfaced, the conversation still lingers. The participant representing the college level stated,

> "I think we assume our students have technology literacy because of their age, but our students are often less literate than we are, especially with the advent of touchscreen apps. It is important we understand what it means to be technology literate and this could serve as a quality assurance tool for faculty, staff and students alike."

A person's technology literacy level was developed based on their exposure to that technology and not their age. Two people from different generations could have the same technology literacy if they were exposed to that technology equally.

Research question three has many facets to its answer. The integration of the ATLAS was feasible to highly feasible at the course, department and college level. It could be integrated with few to moderate policy and procedures changes at the four levels. There would be challenges at all for levels with self-identifying ones' technology literacy level being the primary and consistent challenge. With those challenges also comes advantages and opportunities. All four areas (course, department, college and university) saw the advantage of the ATLAS facilitating faculty and students to understand how their technology literacy skills align with what was required for the course. Similar to the advantages, was the opportunities the ATLAS affords. The ATLAS could be used as a tool to determine the technology literacy skills levels of faculty and use it to improve by identifying professional development opportunities. All four participants identified some level of additional resources, but none expressed any concerns that the increase would be insurmountable. Does the integration of the ATLAS have value? All four participants saw the integration of the ATLAS to be valuable to very valuable at all academic levels.

Application/Implications of Study Results

The outcome sought at the end of the modified Delphi method study was the Academic Technology Literacy ASsessment (ATLAS) rubric. The design of the ATLAS was a combination of a holistic and analytic rubric. The rubric was a typical row and column setup with the rows being the application skill and the columns were the skill level. The field of the rubric was the consensus results from the modified Delphi method study.

The process for using the ATLAS is, first the interested party will look at the course description for the course they are planning on taking. As part of the course descriptions, a TL skill level designator would be part of the description. In the case of the example below, a TL2-WP level has been set by the faculty involved with this course. The TL designates Technology Literacy, the 2 designates the skill level of advanced-beginner, while the WP designates Word Processing. Once the interested party has the TL2-WP information from the course description, they will take the ATLAS and find either the TL2 column or the WP row and follow the column/row to the intersection of the two. The intersecting cell contained the requite skills required by the student. Upper division courses may have required that a student have all of the skills associated in a skill level column and all six areas, in which case it would be listed in the course descriptions as TL2. By knowing the technology literacy requirement of a course beforehand, allowed students to make informed decisions on whether they possess the requisite technology literacy skills to help them be successful in the course. Faculty teaching the course could also use the ATLAS as a tool for assessment of their own technology literacy and the level of technology literacy they will be requiring of their students.

> **WRIT 101W. College Writing I. 3 Credits.** (3 Lec) F,S,Su **(TL2-WP)**
>
> Studies the nature and practice of reading and writing as human interaction, with particular attention to elements of writing process and craft, to present new conceptions of writing as students enter the university writing environment.

The successful voluntary integration of the ATLAS at a small institution with a student body of 300 to a large university with a student body of 17,000 depends largely on people's willingness to integrate the ATLAS. The voluntary integration of the ATLAS within a few courses within a department at any size institution could be consider as a successful integration within the department. The voluntary integration of the ATLAS within a few departments within a college at any size institution could be consider as a successful integration within the college. The voluntary integration of the ATLAS within a few colleges within a university/institution could be consider as a successful integration within the university/institution.

This successful voluntary integration of the ATLAS benefits all levels of students at any size institution from the small institution with a student body of 300 to a large university with a student body of 17,000. All students could benefit from the voluntary self-assessment ATLAS rubric from the freshman taking WRIT 101 at the small institution to doctoral students at the large university/institution taking a graduate course realizing they lack the technology literacy skills required to complete an assignment worth 20% of their grade. All students at any institution, regardless of size, could benefit from the integration of the ATLAS. Students entering any size institution from the workforce, as well as the students just graduating from small rural high schools lacking appropriate technology funds to keep pace, would benefit from the use of the ATLAS.

Limitations

As mentioned in chapter one, limitations of a study were parts of the study that the researcher did not have control of during the study, but believed could affect the study negatively (Gay et al., 2011). A limitation that plagues all Delphi studies, to varying degrees, is participant attrition. Delphi studies that are drawn out over a long period of time are subject to participant attrition due to the changing responsibilities and priorities of the participants. A modified Delphi method study was utilized to potentially reduce the attrition rate. The modified Delphi method study used a pre-defined list for the three rounds reducing the round one contact time as well as subsequent rounds.

Participant selection was limited to the instructors of the CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office during the 2017-2018 academic year. The Montana University System has designated CAPP 120 and CAPP 131 as common courses within the university system requiring instructors to utilize the same textbook. In addition to teaching from the same textbook, instructors teaching CAPP 120 and CAPP 131 must also ensure that at least 80% of the material being covered matches that being taught at other institutions offering CAPP 120 and CAPP 131.

Holding the position as the instructor of the course, they were considered the Subject Matter Experts (SMEs) for this study. The limitation was that not all of the instructors brought the same level of experiential knowledge to the study. This multi-level knowledge structure of the SMEs may have contributed to consensus percentages being more volatile than anticipated. Inaccuracies may have happened due to instructors selecting responses on the survey by guessing due to their lessor experiential knowledge for a certain skill or in a particular area.

Initial contact with the participants for the modified Delphi method study was complicated due to e-mail issues. During the recruitment of participants for the modified Delphi method study, I was under the assumption that I was sending the invitation emails from my .edu account, I was not. All of the invitation emails were being received with a header of @gmail.com. It wasn't until an invited participant notified me and said they would love to participate if I could verify that I was a student and resend the invitation from my .edu account. Because I thought I was, and was not sure what the problem was, I asked one of my dissertation co-chairs to send this person an email verifying that I was indeed a student conducting the said research. This may have seemed more like a delimitation, but the changing of my student .edu email was done globally to all students. I did not make the change resulting in the invitation email coming from my g-mail email. The take away from this was, conduct all correspondence with participants using the email account affiliated with the university.

Reflexivity/Journaling

In chapter three, I mentioned that I would employed a reflective journaling method suggested by Krefting (1991). This journaling method proved to be a valuable method of keeping my positionality in check and recording my thoughts of the large amounts of data this type of data collection method develops. The greatest value this journaling method provided was the tracking of consensus and the deliberation during round three regarding the low 80% consensus levels. This journaling method helped work out the decision to modify the consensus level to a majority consensus for rounds two and three. During the analysis and conclusion phases of this study I was able to reflect by recording my thoughts during the study instead of all at once at the end. This reflective journaling method played a key role in the development of the recommendation for further research.

Recommendations for Further Research

This study focused on identifying exemplary technology literacy definition(s), the development of an Academic Technology Literacy ASsessment (ATLAS) rubric. The ATLAS rubric's development was to aid students and faculty self-assess their technology literacy skills associated with common computer software packages used in higher education classrooms. An assumption existed that students, as well as faculty, were versed in the use of these software packages – this has been identified not to be the case. In addition to the identification of an exemplary technology literacy definition, and development of the ATLAS using a modified Delphi method study, this study also explored the integration of the ATLAS into a course, a department, a college and the university as a whole. The following are recommendations for further research.

Replicate the part of this study aimed to identify an exemplary technology literacy definition(s). As part of the replication study, the technology literacy definitions identified in the late 1970s and 1980s would be included with the list of definitions used in that study along with any additional technology literacy definition not previously identified as part of this study. An additional part of this replication would be to explore the possibility that the way the definitions are visually presented may increase or decrease the likelihood of their selections. This was identified as a possibility during the data analysis section of this study.

Replication of the modified Delphi method study, particularly the selection of the participants. For this study, the 10 SME participants were invited to participate from the fall 2017 and spring semester 2018 cohort of instructors teaching CAPP 120 –

Introduction to Computers and CAPP 131 – Microsoft Office. The selection of these participants was due to their expert knowledge regarding the technology literacy skill associated with the rubric in development. The replication would select participants that are better aligned with the skill. The study would invite participants that are SME's in a particular area. For example, database SME's would be invited to participate in paring the skills/skill levels for database only, the word processing SME's would only participate in pairing the skills/skill levels for word processing only, and so on for all the seven areas. This direct paring of the SME's to their specialty area may help reduce the volatility of the percentages encountered in this study.

Pilot the use of the ATLAS at the course, department and college level. The university level was excluded from the recommendation due to the complexities involved that came to light during the data analysis portion of this study. Each of the participants at the course, department and college level responded favorably to how the ATLAS could be integrated at each of their respective levels. The ability to pilot the ATLAS at each of these levels would provide invaluable information regarding the functionality of the ATLAS outside of the theoretical.

Create a means for students and faculty to acquire the ATLAS skills. Students, as well as faculty, will need a means of acquiring the skills that they are deficient in. This could be done by establishing short term training modules that students and faculty to take to get up to speed on the TL skills they are deficient in. This could be done in the Library, learning center, extended studies center or related center.

Explore a technology literacy skills placement system similar to the Compass placement. The Compass Placement Test is a test used by many higher education institutions to assess incoming student's math and English levels, so they can be registered in the appropriate math and English class. A computerized technology literacy skills system would augment the use of the ATLAS for self-assessing technology literacy skills. For example, students and faculty would start with skills deemed novice and demonstrate their knowledge of how to use them up to when they get the first two incorrect. At the point of the two incorrect demonstrated skills, they would receive that Technology Literacy (TL) skill level, i.e. TL3 or TL-WP3 and a TL-SS2.

Explore the use of Student Response Systems (iClickers) as a means of modified Delphi method study consensus. Student response systems are a classroom survey tool that allows instant feedback to questions. Classrooms that employ student response system technology typically utilizes a two-part system, a base receiver unit and remotes that users use to transmit their choice to the receiver unit. This technology could be used during a classic Delphi face-to-face rounds where participants can respond to prompts by the researcher using the remotes. The researcher will receive instant consensus (feedback) results. The researcher can adjust the conversation with participants and initiate another round seeking consensus. This method could also be used at faculty/staff meeting when consensus is sought.

Explore consensus methodology. During this study a consensus level of 80% was set for the level of consensus needed for skills to be moved from the survey to the ATLAS. With 10 participants, eight of the 10 needed to pick the same skill level. It was determined that for every five participants, one could choose a skill other than what the other chose. For example, if there were 15 participants, three could choose a different skill than the others and still achieve an 80% consensus. For this study an adjustment was made during round two to set the consensus level to a majority of participants responded the same. In this case 60% and above. The exploration of the consensus methodology would look deeper at von der Gracht's (2012) consensus measurement in Delphi Studies. Comparing the different consensus measurements and when is one better to use than another.

Explore the use of incentives in research. How is the use of incentives seen in research? Is the use of incentives seen as coercive (Singer & Bossarte, 2006)? Explore Leverage-Saliency theory of survey participation (Groves, Singer, & Corning, 2000). For this study, incentives were given to the 10 participants of the modified Delphi method study. A total of 29 invitations were sent out, and as a part of the invitations it was mentioned that those that completed all three rounds would receive a $50.00 Amazon gift card. Of the 10 that participated, six wanted the results of the study, so it is unclear if these six would have participated for the result and not the incentive. With a larger than average incentives ($5-$10), a greater number of participants was anticipated. After completion, a follow up survey was conducted to see if participants would have still participated, and complete all three rounds, of the modified Delphi method study if the incentive was not offered, ninety percent responded they would have still participated.

Explore the use of the ATLAS as a potential means to the cognitive load students/faculty may encounter when their technology literacy is deficient. As mentioned in chapter one, Cognitive Load Theory (CLT) is a vast construct. The introduction of this theory in chapter one was to provide readers with a brief understanding of the theory, the complexities of the theory. The introduction of the CLT and how the ATLAS could provide users a means of identifying the source of the cognitive load and how to reduce the load.

Lessons Learned

At the center of this study was a modified Delphi method study. Delphi studies in general are a very time intensive method for gathering data. The use of this data collection method required critical focus on a very good understanding of how a Delphi works, the selection of SME participants and the selection of the appropriate consensus method. Understanding that a Delphi, whether it be a classical Delphi or some modification of the classical Delphi, all are very time intensive and require diligence to complete. As mentioned throughout this study, participant attrition is the item the plaques this type of study. Participants will drop out of the study for various reasons. One method used in this study to retain participants was the use of an incentive. To gain a better understanding of the role the incentive played in this study, I surveyed the participants asking the if they would have participated in all three rounds if an incentive was not offered. Nine out of 10 said the still would have participated in the study if no incentive was offered. Another factor may have played a larger role than the incentive. Six out of 10 wanted to know if they could have the results of the modified Delphi method study after the study was complete. All aspects of a modified Delphi method study or any study centers around the selection of participants. The selection of participants for a Delphi study requires the selection of experts in the area being studied. This will vary the number of participants greatly. In some areas, there may only be a select few experts in the area being studied, while other areas may have a much greater number of SME participants. Select your participants with precision. The last key component of a Delphi is selecting the appropriate consensus method. There is a limited number of articles that look at Delphi method study consensus methods. An article by von der Gracht (2012) provided great council when deciding the appropriate consensus method for this study.

In many cases, the use of a Delphi method study is the best method to use to collect data related to a specific topic. For this study, a modified Delphi method study was the ideal methodology to extract precision responses from the group of 10 SME participants. The quality of the responses far outweighed the amount of time required to conduct this modified Delphi method study.

At the conclusion of any Delphi study, there will be items that do not reach consensus, this study was no different. This modified Delphi method study had 38 skills that did not reach consensus. Analyzing the remaining 38 skills, all seemed to be deadlocked at the consensus level over all three rounds. For example, in round one consensus levels for the computer skill of “Retrieve a deleted file” were novice 50%, adv. beginner 40%, competent 10% and proficient and expert at 0%. For round two the consensus went to novice 50% and adv. beginner at 50%. For the third and final round the consensus was novice 10%, adv. beginner 40%, competent 50% and proficient and expert at 0%. While there was a large redistribution of responses from novice to competent, consensus at the 80% or majority was never reached. Reflecting on this skill, I wondered if consensus would have been reached if the wording of the skill was changed from “Retrieve a deleted file” to “Retrieve a deleted file from the Recycle Bin” would have altered the responses. I believe this change to the wording would have help the skill reach a majority consensus level of 60% or greater. This hovering just under the majority consensus level for rounds two and three was common for the remaining 38 skills. A reevaluation of the wording for these remaining skills might yield a greater number of them reaching consensus.

Conclusion of Study

There have been many historical events that have brought education and technology together, and in some cases, technology designed specifically for education. With the advent of the pencil, blackboard, computers, internet and advanced computer display systems, technology in various forms and functions have filtered their way into the educational setting. This filtering of technology into the classroom setting has introduced many paradigms defining this linkage of technology and pedagogy.

To better understand technology, it takes a certain level of literacy, technology literacy. Johnson (2004) stated that “the first sign of technology literacy is knowing when to use technology and when not to use technology” (p. 30) A student in any educational institution before the introduction of technology into classrooms such as mechanical typewriters, then electronic typewriters, then computers, educational institutions were only concerned with learning and understanding the standard four basic literacies - listening, speaking, reading and writing. Today, students from young children in elementary school to the adult students in postsecondary educational institutions and the life-long learners, are faced with an ever-increasing required fifth literacy of today: technology literacy (Roblyer & Bennett, 2001). Roblyer and Bennett defined the fifth literacy as "joining basic literacy and computer, technology, and information literacy" (2001, p. 8).

The purpose of this study was to identify exemplary technology literacy definitions from current technology literacy definitions. Having an example of what experts consider and exemplary technology literacy definition help with the understanding the roll of technology literacy. The SME participants of this study reduced 25 technology literacy definitions down to a single exemplary technology literacy definition. The search for an exemplary technology literacy definition(s) is unique to this study. The only similar study done was by Doyle (1992) that had a component that looked at creating a better definition of information literacy using a Delphi study.

In addition to the exemplary technology literacy definition, SME's helped develop the Academic Technology Literacy ASsessment (ATLAS) rubric. I started to wonder how one's own technology literacy may cause them to fall behind in their coursework, not because they do not understand the course material, but because they do not possess the proper embedded, ancillary and undisclosed technology literacy skills required to be successful in the course. Students enrolled in courses with differing levels experiential knowledge of the subject matter, and understanding of what was required of them, because it was outlined in the course descriptions provided in the college catalog. However; these course descriptions of the material did not explain what ancillary technology literacy skills would be required to successfully support the primary course material. Students had no way of knowing to what level technology is integrated into the course until they are enrolled and attending class. Compounding the selection of courses; courses with the same title and course material may have vastly differing levels of technology integration leaving students selecting and enrolling in classes without any structured mechanism to identify the level of technology literacy required within the course and self-assess if they possessed the requisite technology literacy skills required.

The development of the ATLAS provides a mechanism for students to better understand what level of technology literacy will be required of them when they take a course that has integrated the ATLAS. The ATLAS was not developed for the sole benefit to the students. It could provide great benefit for faculty as well by providing them a means to self-assess their technology literacy skills. Some institutions might consider the ATLAS tool as mechanism for faculty and students to self-assess where new skills are needed, instead of using it as a tool to determine if they should take a class or not.

The final purpose of this study was to identify how the ATLAS could be integrated at the course, department, college and university level. Participants for each of these areas responded to questions regarding feasibility, governance (policies and procedures), challenges, advantages, opportunities, resources (financial and personnel), and value of the ATLAS. The integration of the ATLAS was favorable at varying levels at all four areas. The greatest take-away from the responses regarding integration of the ATLAS was that participants have observed that they did not see the black and white, digital native, digital immigrant separation of technology literacy as proclaimed by Prensky (2001). These perceived digital natives were in many cases as technology illiterate as the perceived digital immigrants.

Students as well as faculty are finding themselves in classrooms with a diverse mixed-age demographic, course and learning environments that are increasingly being technology enhanced. Students' cognitive systems are being taxed at ever increasing rate. Knowing the technology literacy requirement of a course beforehand would allow students to make informed decisions. Do I have the requisite technology literacy skills to be successful in this course? Faculty teaching the course could use the ATLAS as a tool for assessing their technology literacy skills as well as the student in their courses. This study provides students, faculty, and institutions with an understanding of technology literacy definitions and a tangible ATLAS rubric system that will provide those that feel overwhelmed (cognitive overload) with technology to identify where they are weak. Administrators can identify actual steps on how to institutionalize the ATLAS rubric at the course, department, college and university level.

REFERENCES CITED

Abbott, C. (2001). *ICT: Changing education*: Psychology Press.

Adler, M., & Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*: Jessica Kingsley Publishers.

Agnes, E., & Guralnik, D. (2006). *Consensus, Webster's new world college dictionary*: Macmillan.

Al-Khalifa, H. S. (2013). *Applying Knowledge, Skills and Abilities in undergraduate research seminar course.* Paper presented at the 2013 12th International Conference on Information Technology Based Higher Education and Training (ITHET).

ALA, American Library Association. (1989). Presidential Committee on Information Literacy: Final Report.

Alexandrov, A. V., Pullicino, P. M., Meslin, E. M., & Norris, J. W. (1996). Agreement on disease-specific criteria for do-not-resuscitate orders in acute stroke. *Stroke, 27*(2), 232-237.

American Educational Research Association [AERA]. (1999). *Standards for educational and psychological testing*. Washington, DC: American Educational Research Association.

American Library Association, A., ,. (1989). Presidential Committee on Information Literacy: Final Report. Retrieved from http://www.ala.org/acrl/publications/whitepapers/presidential

American Library Association, A., ,. (2018). Information Literacy Competency Standards for Higher Education. Retrieved from http://www.ala.org/Template.cfm?Section=Home&template=/ContentManagement/ContentDisplay.cfm&ContentID=33553#ildef

Anderson, V. A. (2011). *Defining the EdD and PhD in education: a delphi study*. (Doctor of Philosophy), North Dakota State University.

Argyris, C. (2004). Reflection and beyond in research on organizational learning. *Management Learning, 35*(4), 507-509.

Arnfield, R. V., & Schnittger, J. R. (1969). *Technological forecasting*: Edinburgh University Press Edinburgh.

Artino, A. R. (2008). Cognitive load theory and the role of learner experience: An abbreviated review for educational practitioners. *Aace Journal, 16*(4), 425-439.

Ashenhurst, R. L. (1972). Curriculum recommendations for graduate professional programs in information systems. *Communications of the ACM, 15*(5), 363-398.

Association, I. T. E., & Project, T. f. A. A. (1996). *Technology for all Americans: A rationale and structure for the study of technology*: International Technology Education Association.

Association of American Colleges and Universities [AAC&U]. (2016). Information Literacy VALUE Rubric. Retrieved from https://www.aacu.org/value/rubrics/information-literacy

Association of American Colleges and Universities. (2009). Inquiry and analysis VALUE rubric. . Retrieved from https://www.aacu.org/value/rubrics/inquiry-analysis

Association of College Research Libraries, A., ,. (2000). *Information literacy competency standards for higher education*: ACRL.

Association of College Research Libraries, A., ,. (2000). Presidential Committee on Information Literacy: Final Report.

Bakarman, A. A. (2011). Attitude, skill, and knowledge:(ASK) a new model for design education. *Proceedings of the Canadian Engineering Education Association*.

Barnett, W. P., & Carroll, G. R. (1995). Modeling internal organizational change. *Annual review of sociology, 21*(1), 217-236.

Bates, A. W., & Sangra, A. (2011). *Managing technology in higher education: Strategies for transforming teaching and learning*: John Wiley & Sons.

Beer, M., & Nohria, N. (2000). Cracking the code of change. *Harvard Business Review, 78*(3), 133-141.

Belanger, J., Zou, N., Mills, J. R., Holmes, C., & Oakleaf, M. (2015). Project RAILS: lessons learned about rubric assessment of information literacy skills. *portal: Libraries and the Academy, 15*(4), 623-644.

Bent, M., & Stubbings, R. (2011). *The SCONUL Seven Pillars of Information Literacy. Core Model For Higher Education*. Retrieved from London: http://www.sconul.ac.uk/sites/default/files/documents/coremodel.pdf

Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative research, 15*(2), 219-234.

Bertoline, G. R., Wiebe, E. N., Miller, C. L., & Nasman, L. O. (2005). *Fundamentals of graphics communication*: McGraw-Hill.

Borkman, T. (1976). Experiential Knowledge: A New Concept for the Analysis of Self-Help Groups. *Social Service Review, 50*(3), 445-456.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn: Brain, mind, experience, and school*: National Academy Press.

Breivik, P. S., & Gee, E. G. (1989). *Information literacy: Revolution in the library*. New York: Ace Oryx.

Bright, J. R. (1968). *Technological forecasting for industry and government*. NJ: Prentice-Hall.

Brookhart, S. M., & Chen, F. (2015). The quality and effectiveness of descriptive rubrics. *Educational Review, 67*(3), 343-368.

Brosnan, M. J. (2002). *Technophobia: The psychological impact of information technology*: Routledge.

Buck, A. J., Gross, M., Hakim, S., & Weinblatt, J. (1993). Using the Delphi process to analyze social policy implementation: A post hoc case from vocational rehabilitation. *Policy Sciences*, *26*(4), 271-288.

Buckingham, D. (2006). Defining digital literacy: What do young people need to know about digital media? *DIGITAL KOMPETANSE, 1*, 263-276.

Burke, W. W. (2017). *Organization change: Theory and practice*: Sage publications.

Callison, D. (2000). Rubrics. *School Library Media Activities Monthly, 17*(2), 34.

Campbell, S., & Cantrill, J. (2001). Consensus methods in prescribing research. *Journal of clinical pharmacy and therapeutics, 26*(1), 5-14.

Cantor, J. A. (1992). *Delivering Instruction to Adult Learners*. Toronto, Canada: Wall and Emerson.

Cetron, M. J. (1969). Technological forecasting: a practical approach. Gordon and Breach. *Science, New York, London, Paris*.

Cetron, M. J., & Ralph, C. A. (1971). *Industrial applications of technological forecasting*. NY: Wiley and Sons.

Chakravarti, A., Vasanta, B., Krishnan, A., & Dubash, R. (1998). Modified Delphi methodology for technology forecasting case study of electronics and information technology in India. *Technological Forecasting and Social Change, 58*(1), 155-165.

Chang, A. M., Gardner, G. E., Duffield, C., & Ramis, M. A. (2010). A Delphi study to validate an advanced practice nursing tool. *Journal of advanced nursing, 66*(10), 2320-2330.

Cheney, P. H., Hale, D. P., & Kasper, G. M. (1990). Knowledge, skills and abilities of information systems professionals: past, present, and future. *Information & management, 19*(4), 237-247.

Clayton, M. J. (1997). Delphi: a technique to harness expert opinion for critical decision-making tasks in education. *Educational Psychology, 17*(4), 373-386.

Colorado Department of Education. (2009). Technology Literacy Assessment Project. Retrieved from http://www.coloradotechliteracy.org/org/documentation/pdfs/module1pdfs/TLAPMod-1.pdf

Conti, M. J. (2012). *The online teaching skills and best practices of virtual classroom teachers: A mixed method Delphi study.* University of Phoenix.

Cooper, D. R., & Schindler, P. S. (2003). *Business research methods* (11th ed.). New York, NY: McGraw-Hill.

Corrin, L., Lockyer, L., & Bennett, S. (2010). Technological diversity: An investigation of students' technology use in everyday life and academic study. *Learning, media and technology, 35*(4), 387-401.

Cottam, H., Roe, M., & Challacombe, J. (2004). Outsourcing of trucking activities by relief organisations. *Journal of Humanitarian Assistance, 1*(1), 1-26.

Cramer, C. K., Klasser, G. D., Epstein, J. B., & Sheps, S. B. (2008). The Delphi process in dental research. *Journal of Evidence Based Dental Practice, 8*(4), 211-220.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (third ed.). Thousand Oaks, CA: Sage publications.

Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches*: Sage.

Cuban, L. (1993). Computers meet classroom: Classroom wins. *Teachers College Record, 95*(2), 185.

Custer, R. L., Scarcella, J. A., & Stewart, B. R. (1999). The modified Delphi technique-A rotational modification. *Journal of Career and Technical Education, 15*(2).

Cuvar, K. M. (2015). *Balanced and collaborative outsourcing of IT services: A qualitative Delphi study of enterprise partnerships.* University of Phoenix.

Dajani, J. S., Sincoff, M. Z., & Talley, W. K. (1979). Stability and agreement criteria for the termination of Delphi studies. *Technological Forecasting and Social Change, 13*(1), 83-90.

Dalkey, N. (1968). *Predicting the future*: Rand Corporation.

Dalkey, N., & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management science, 9*(3), 458-467.

Dalkey, N. C., Brown, B. B., & Cochran, S. (1969). *The Delphi method: An experimental study of group opinion* (Vol. 3): Rand Corporation Santa Monica, CA.

Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*: Harvard Business Press.

Davidson, P., Merritt-Gray, M., Buchanan, J., & Noel, J. (1997). Voices from practice: Mental health nurses identify research priorities. *Archives of Psychiatric Nursing, 11*(6), 340-345.

Dawson, P. (2017). Assessment rubrics: Towards clearer and more replicable design, research and practice. *Assessment & Evaluation in Higher Education, 42*(3), 347-360.

Day, J., & Bobeva, M. (2005). A generic toolkit for the successful management of Delphi studies. *The Electronic Journal of Business Research Methodology, 3*(2), 103-116.

De Jong, T., & Ferguson-Hessler, M. G. (1996). Types and qualities of knowledge. *Educational psychologist, 31*(2), 105-113.

De Vet, E., Brug, J., De Nooijer, J., Dijkstra, A., & De Vries, N. K. (2005). Determinants of forward stage transitions: a Delphi study. *Health Education Research, 20*(2), 195-205.

De Villiers, M. R., De Villiers, P. J., & Kent, A. P. (2005). The Delphi technique in health sciences education research. *Medical teacher, 27*(7), 639-643.

Dednam, E. (2009). *Away with computer literacy modules at universities, or not?* Paper presented at the Proceedings of the 2009 Annual Conference of the Southern African Computer Lecturers' Association.

Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. (1975). *Group techniques for program planning: A guide to nominal group and delphi processes*: Scott, Foresman Glenview, IL.

Demers, C. (2007). *Organizational change theories: A synthesis*: Sage.

Dillman, D. A., Christenson, J. A., Carpenter, E. H., & Brooks, R. M. (1974). Increasing mail questionnaire response: a four state comparison. *American Sociological Review*, 744-756.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: the tailored design method*: John Wiley & Sons.

Doke, E. R., & Swanson, N. (1995). Decision variables for selecting prototyping in information systems development: A Delphi study of MIS managers. *Information & management, 29*(4), 173-182.

Doost, R. K. (1999). Computers and accounting: where do we go from here? *Managerial Auditing Journal, 14*(9), 487-488. doi:doi:10.1108/02686909910301574

Doyle, C. S. (1992). Outcome Measures for Information Literacy within the National Education Goals of 1990. Final Report to National Forum on Information Literacy. Summary of Findings.

Dreyfus, H. L., & Dreyfus, S. E. (1980). *A five-stage model of the mental activities involved in directed skill acquisition*. Retrieved from

Du Plessis, E., & Human, S. P. (2007). The art of the Delphi technique: highlighting its scientific merit. *Health SA Gesondheid, 12*(4), 13-24.

Dubey, R. (2014). Difference between Competencies & Skills. Retrieved from https://www.linkedin.com/pulse/20141118050806-52304125-difference-between-competencies-skills

Dugger Jr, W. E. (2001). Standards for technological literacy. *Phi Delta Kappan, 82*(7), 513.

Dugger, W. E. (1997). Technology for All Americans: a rationale and structure for the study of technology-executive summary. *Journal of Design & Technology Education, 2*(2).

Dyrenfurth, M., & Kozak, M. (1991). Technological literacy, 40th yearbook of the Council on Technology Teacher Education. *Peoria, IL: Glencoe*.

Enhancing Education Thruough Technology Act of 2001, Pub. L. No. 107-110, Title II, Part D, § 2401 (2001).

Erffmeyer, R. C., & Lane, I. M. (1984). Quality and acceptance of an evaluative task: The effects of four group decision-making formats. *Group & Organization Management, 9*(4), 509-529.

Estrella Mountain Community College. (2017). Technology Literacy. Retrieved from https://www.estrellamountain.edu/employees/committees/saac/technological-literacy

Eubank, B. H., Mohtadi, N. G., Lafave, M. R., Wiley, J. P., Bois, A. J., Boorman, R. S., & Sheps, D. M. (2016). Using the modified Delphi method to establish clinical consensus for the diagnosis and treatment of patients with rotator cuff pathology. *BMC medical research methodology, 16*(1), 56.

Every Student Succeeds Act of 2015, Pub. L. No. 1141-95 § 1112, 10 A&B, 129 Stat. 392 (2015).

Fan, C. K., & Cheng, C. L. (2006). A study to identify the training needs of life insurance sales representatives in Taiwan using the Delphi approach. *International Journal of Training and Development*, *10*(3), 212-226.

Fazey, L., Fazey, J. A., Salisbury, J. G., Lindenmayer, D. B., & Dovers, S. (2006). The nature and role of experiential knowledge for environmental conservation. *Environmental conservation, 33*(01), 1-10.

Fish, L. S., & Busby, D. M. (1996). The delphi method. *Research methods in family therapy*, 469-482.

Florida Gulf Coast University. (2017). Technology Skills Self-Assessment. Retrieved from https://survey.fgcu.edu/Survey.aspx?s=311d40c08e234f9181d7f97e6623fbcc

Foote, M. Q., & Bartell, T. G. (2011). Pathways to equity in mathematics education: How life experiences impact researcher positionality. *Educational Studies in Mathematics*, *78*(1), 45-68.

Fortier, J. D., Potter, C. J., Grady, S. M., Lohr, N. J., & Klein, J. (1998). Wisconsin's model academic standards for information and technology literacy. *Madison, WI: Wisconsin Department of Public Instruction*.

Gardner, D. P. (1983). *A Nation At Risk: The Imperative For Educational Reform. An Open Letter to the American People. A Report to the Nation and the Secretary of Education*. Retrieved from

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications* (Tenth ed.): Pearson Higher Ed.

Gillmon, E. (1991). *Keyboard Proficiency: An Essential Skill in a Technological Age. Number 2*: ERIC.

Gilster, P. (1997). *Digital literacy*. New York: Wiley Computer Pub.

Glenn, M., & D'Agostino, D. (2008). The future of higher education: How technology will shape learning. *New Media Consortium*.

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems, 21*(2), 135-146.

Goodchild, L. F., & Wechsler, H. S. (1997). *The History of Higher Education. ASHE Reader Series*: ERIC.

Goodman, C. M. (1987). The Delphi technique: a critique. *Journal of advanced nursing, 12*(6), 729-734.

Green, B., Jones, M., Hughes, D., & Williams, A. (1999). Applying the Delphi technique in a study of GPs' information requirements. *Health & social care in the community, 7*(3), 198-205.

Greiner, L. (1967). Successful organization change: the ingredients that make it stick. *Management Review, 56*(8), 48-55.

Groves, R. M., Singer, E., & Corning, A. (2000). Leverage-saliency theory of survey participation: description and an illustration. *The Public Opinion Quarterly, 64*(3), 299-308.

Gunaydin, H. M. (2006). The Delphi method. *Optimization Group, accessed at http://web.iyte.edu.tr/~muratgunaydin/delphi.htm, 16*.

Gurung, B., & Rutledge, D. (2014). Digital learners and the overlapping of their personal and educational digital engagement. *Computers & education, 77*, 91-100.

Hack, C. (2015). Analytical rubrics in higher education: A repository of empirical data. *British Journal of Educational Technology, 46*(5), 924-927.

Hadassah Medical Center. (2017). The Development and Validation of Questionnaires. Retrieved from http://www.hadassah-med.com/media/2016259/thedevelopmentandvalidationofquestionnaires.pdf

Hafner, J., & Hafner, P. (2003). Quantitative analysis of the rubric as an assessment tool: an empirical study of student peer-group rating. *Int. J. Sci. Educ., 25*(12), 1509-1528.

Hague, C., & Payton, S. (2011). Digital literacy across the curriculum. *Curriculum Leadership, 9*(10).

Hahn, E. J., & Rayens, M. K. (1999). Consensus for tobacco policy among former state legislators using the policy Delphi method. *Tobacco Control, 8*(2), 137-140.

Hallowell, M. R., & Gambatese, J. A. (2010). Qualitative Research: Application of the Delphi Method to CEM Research. *Journal of Construction Engineering and Management, 136*(1), 99-107. doi:doi:10.1061/(ASCE)CO.1943-7862.0000137

Hansen, J. W. (2003). *To change perceptions of technology programs.* Paper presented at the The Journal of Technology Studies.

Harvard University. (2017). History. Retrieved from http://www.harvard.edu/about-harvard/harvard-glance/history

Hassani, S., & Rahman, A. b. A. (2011). Knowledge Management Capabilities Rubrics. *American Journal of Economics and Business Administration, 3*(3), 439.

Hasson, F., & Keeney, S. (2011). Enhancing rigour in the Delphi technique research. *Technological Forecasting and Social Change, 78*(9), 1695-1704.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of advanced nursing, 32*(4), 1008-1015.

Heberlein, T. A., & Baumgartner, R. (1978). Factors affecting response rates to mailed questionnaires: A quantitative analysis of the published literature. *American Sociological Review*, 447-462.

Helmer-Hirschberg, O. (1966). *The Delphi method for systematizing judgments about the future* (Vol. 61): Institute of Government and Public Affairs, University of California.

Helmer, O. (1967). *Analysis of the future: The Delphi method*. Retrieved from

Helmer, O., & Rescher, N. (1959). On the epistemology of the inexact sciences. *Management science, 6*(1), 25-52.

Helsper, E. J., & Eynon, R. (2010). Digital natives: where is the evidence? *British educational research journal*, *36*(3), 503-520.

Herr, K., & Anderson, G. L. (2014). *The action research dissertation: A guide for students and faculty*: Sage publications.

Hersh, R. H. (1983). How to Avoid Becoming a Nation of Technopeasants. *The Phi Delta Kappan, 64*(9), 635-638.

Heyman, E. (2010). *Overcoming student retention issues in higher education online programs: A Delphi study*: University of Phoenix.

Hilberg, J. S., & Meiselwitz, G. (2008). *Undergraduate fluency with information and communication technology: perceptions and reality*. Paper presented at the Proceedings of the 9th ACM SIGITE conference on Information technology education.

Hobbs, R. (2010). *Digital and Media Literacy: A Plan of Action. A White Paper on the Digital and Media Literacy Recommendations of the Knight Commission on the Information Needs of Communities in a Democracy*: ERIC.

Holum, A., & Gahala, J. (2001). Critical Issue: Using Technology To Enhance Literacy Instruction.

Hsu, C.-C., & Sandford, B. A. (2010). Delphi Technique *Encyclopedia of Research Design*: Sage Publications.

Hsu, C.-C. S., Brian A. (2007). The Delphi technique: making sense of consensus. *Practical assessment, research & evaluation, 12*(10), 1-8.

Hughes, M. (2011). Do 70 per cent of all organizational change initiatives really fail? *Journal of Change Management, 11*(4), 451-464.

ICT Literacy. (2002). Digital transformation: A framework for ICT literacy. *Educational Testing Service*.

Ingerman, Å., & Collier-Reed, B. (2011). Technological literacy reconsidered: A model for enactment. *International Journal of Technology and Design Education, 21*(2), 137-148.

International Society for Technology in Education [ISTE]. (2007a). NETS for Students Profiles for Technology Literate Students. Retrieved from https://www.iste.org/docs/pdfs/nets-s-2007-student-profiles-en.pdf?sfvrsn=4

International Society for Technology in Education [ISTE]. (2007b). Standards. Retrieved from http://www.iste.org/standards/iste-standards

International Society for Technology in Education [ISTE]. (2017). ISTE Standards for Students. Retrieved from https://www.iste.org/standards/for-students

International Technology Education Association, & Technology for All Americans Project. (1996). *Technology for all Americans: A rationale and structure for the study of technology*: International Technology Education Association.

International Technology Education Association [ITEA]. (2000). *Standards for technological literacy: Content for the study of technology*. Reston, Virginia: International Technology Education Association.

International Technology Education Association [ITEA]. (2003). *Advancing excellence in technological literacy: Student assessment, professional development, and program standards* (1887101039). Retrieved from

Islam, D. M., Dinwoodie, J., & Roe, M. (2006). Promoting development through multimodal freight transport in Bangladesh. *Transport Reviews, 26*(5), 571-591.

James Madison University. (2017). Madison Research Essentials: Information Literacy Competency @JMU. Retrieved from https://www.jmu.edu/gened/MREST.shtml

James, N. (2008). Authenticity *The SAGE Encyclopedia of Qualitative Research Methods*: Sage Publications.

Jantsch, E. (1967). *Technological forecasting in perspective*: OCDE.

Jensen, C. H., Voisinet, D. D., & Helsel, J. D. (1989). *Computer-aided Engineering Drawing Using AutoCAD*: McGraw-Hill, Inc.

Jensen, M., Guttschow, G., & Hill, M. (2002). Technophobia and Teaching Technology-Rich Freshman Science Courses: Overcoming the Digital Divide. *Journal of College Science Teaching, 31*(6), 360-363.

Johnson, B., & Christensen, L. (2012). *Educational research: Quantitative, qualitative, and mixed approaches* (Fourth ed.): Sage.

Johnson, D. (2004). *Machines are the Easy Party; People are the Hard Part: Observations about Making Technology Work in Schools*: Beaver's Pond Press Book.

Johnston, B., & Webber, S. (2003). Information literacy in higher education: a review and case study. *Studies in higher education, 28*(3), 335-352.

Jones, B., & Flannigan, S. L. (2006). Connecting the digital dots: Literacy of the 21st century. *Educause Quarterly, 29*(2), 8-10.

Jonsson, A. (2014). Rubrics as a way of providing transparency in assessment. *Assessment & Evaluation in Higher Education, 39*(7), 840-852.

Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity and educational consequences. *Educational research review, 2*(2), 130-144.

Judson, E. (2010). Improving technology literacy: does it open doors to traditional content? *Educational Technology Research and Development, 58*(3), 271-284.

Kaestle, C. F. (1985). The history of literacy and the history of readers. *Review of research in education*, 11-53.

Kaminski, K., Seel, P., & Cullen, K. (2003). Technology Literate Students. *EDUCAUSE Quarterly*(Number 3), 6.

Katz, M. S. (1976). *A history of compulsory education laws*: Phi Delta Kappa Educational Foundation.

Kay, C., & Moncarz, E. (2004). Knowledge, skills, and abilities for lodging management. *Cornell Hotel and Restaurant Administration Quarterly, 45*(3), 285-298.

Kee, J. E., & Newcomer, K. E. (2008). Why do change efforts fail? *Public Manager, 37*(3), 5.

Keeney, S., Hasson, F., & McKenna, H. (2006). Consulting the oracle: ten lessons from using the Delphi technique in nursing research. *Journal of advanced nursing, 53*(2), 205-212.

Keeney, S., Hasson, F., & McKenna, H. P. (2001). A critical review of the Delphi technique as a research methodology for nursing. *International journal of nursing studies*, *38*(2), 195-200.

Keeney, S., Hasson, F., & McKenna, H. P. (2011). *The Delphi technique in nursing and health research*. Chichester, West Sussex: Wiley-Blackwell.

Kennedy, H. P. (2004). Enhancing Delphi research: methods and results. *Journal of advanced nursing, 45*(5), 504-511.

Kezar, A. (2014). *How colleges change: Understanding, leading, and enacting change*: Routledge.

Knight-McCord, J., Cleary, D., Grant, N., Herron, A., Lacey, T., Livingston, T., . . . Emanuel, R. (2016). What social media sites do college students use most? *Journal of Undergraduate Ethnic Minority Psychology, 2*, 21.

Knight, L. A. (2006). Using rubrics to assess information literacy. *Reference Services Review, 34*(1), 43-55.

Kölling, M., & McKay, F. (2016). Heuristic Evaluation for Novice Programming Systems. *ACM Transactions on Computing Education (TOCE), 16*(3), 12.

Koning, A. (2001). Information literacy in New Zealand public libraries. *Australasian Public Libraries and Information Services, 14*(4), 159.

Koutropoulos, A. (2011). Digital Natives: Ten Years After. *Journal of Online Learning and Teaching, 7*(4), 525-538.

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. *American journal of occupational therapy, 45*(3), 214-222.

Kurland, D. M., & Kurland, L. C. (1987). Computer applications in education: A historical overview. *Annual review of computer science, 2*(1), 317-358.

Lanford, H. W. (1972). *A Synthesis of Technological Forecasting Methodologies. Technological Forecasting Methodologies.: a Synthesis*: American Management Association.

Lanford, H. W., & Association, A. M. (1972). *Technological forecasting methodologies: A synthesis*: American Management Association.

Last, L., & Fulbrook, P. (2003). Why do student nurses leave? Suggestions from a Delphi study. *Nurse education today, 23*(6), 449-458.

Leedy, P., & Ormrod, J. (2010). *Practical research: Planning and Design* (Ninth ed.): Pearson.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research: Planning and design* (Ninth ed.): Pearson.

Leslie, T. F. (1997). *Comparing two approaches to questionnaire design: Official government versus public information design.* Paper presented at the Proceedings of the American Statistical Association, Section on Survey Methods.

Leu, D. J., & Kinzer, C. K. (2000). The convergence of literacy instruction with networked technologies for information and communication. *Reading Research Quarterly, 35*(1), 108-127.

Linstone, H. A., & Turoff, M. (1975). *The Delphi method: Techniques and applications* (Vol. 29): Addison-Wesley Reading, MA.

Linstone, H. A., & Turoff, M. (2002). *The Delphi method: Techniques and applications* (Vol. 18): Addison-Wesley Publishing Company, Advanced Book Program.

Littlejohn, A., Beetham, H., & McGill, L. (2012). Learning at the digital frontier: a review of digital literacies in theory and practice. *Journal of Computer Assisted Learning, 28*(6), 547-556.

Loughlin, K. G., & Moore, L. F. (1979). Using Delphi to achieve congruent objectives and activities in a pediatrics department. *Academic Medicine*, *54*(2), 101-106.

Luft, J. (1997). Design your own rubric. *Science Scope*, *20*, 25-27.

Luft, S. (2009). [Personal observation of CAD -125 - Introduction to Computer Aided Drafting].

Lunsford, D. A., & Fussell, B. C. (1993). Marketing business services in central Europe: the challenge: a report of expert opinion. *Journal of Services Marketing, 7*(1), 13-21.

MacCarthy, B. L., & Atthirawong, W. (2003). Factors affecting location decisions in international operations-a Delphi study. *International Journal of Operations & Production Management*, *23*(7), 794-818.

Marmel, E. (2016). *Office 2016 Simplified*. Indianapolis, IN: Visual.

Martin, A. (2005). DigEuLit–a European framework for digital literacy: a progress report. *Journal of eLiteracy, 2*(2), 130-136.

Martin, A. (2006). Literacies for the digital age. *Digital literacies for learning*, 3-25.

Martin, A., & Grudziecki, J. (2006). DigEuLit: concepts and tools for digital literacy development. *Innovation in Teaching And Learning in Information and Computer Sciences, 5*(4), 1-19.

Martino, J. P. (1968). An experiment with the Delphi procedure for long-range forecasting. *IEEE Transactions on Engineering Management*(3), 138-144.

Maurer, R. (2010). Applying what We've learned about change. *The Journal for Quality and Participation, 33*(2), 35.

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41): Sage publications.

Mayo Clinic. (2016). Diseases and Conditions-Phobias. Retrieved from http://www.mayoclinic.org/diseases-conditions/phobias/basics/definition/con-20023478

McCaslin, M. L. (2008). Pragmatism *The SAGE Encyclopedia of Qualitative Research Methods*: Sage Publications.

McDonald, D. S. (2004). Computer literacy skills for computer information systems majors: A case study. *Journal of Information Systems Education, 15*(1), 19.

McKee, S. (2015). Is It Questionnaire Or Survey? Retrieved from https://www.surveygizmo.com/survey-blog/taking-the-question-out-of-questionnaires/

McKenna, H. P. (1994). The Delphi technique: a worthwhile research approach for nursing? *Journal of advanced nursing*, *19*(6), 1221-1225.

McMillan, S. (1996). Literacy and computer literacy: definitions and comparisons. *Computers & education, 27*(3), 161-170.

Merriam-Webster. (2016a). Definition of Pragmatic. Retrieved from http://www.merriam-webster.com/dictionary/pragmatic

Merriam-Webster. (2016b). Definition of social media. Retrieved from http://www.merriam-webster.com/dictionary/social%20media

Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*: Sage publications.

Michigan Tech. (2017). Information Literacy. Retrieved from http://www.mtu.edu/library/instruction/information-literacy/

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*: sage.

Mills, A. J., Durepos, G., & Wiebe, E. (2010). Encyclopedia of case study research: Iterative. Retrieved from http://proxybz.lib.montana.edu/login?url=http://search.credoreference.com/content/entry/sagecsr/iterative/0?institutionId=7751

Mitchell, M. P. (1998). Nursing education planning: a Delphi study. *Journal of Nursing Education*, *37*(7), 305-307.

Moeller, B., & Reitzes, T. (2011). Integrating Technology with Student-Centered Learning. A Report to the Nellie Mae Education Foundation. *Education Development Center, Inc*.

Mokkink, L. B., Terwee, C. B., Patrick, D. L., Alonso, J., Stratford, P. W., Knol, D. L., . . . De Vet, H. C. (2010). The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Quality of life research, 19*(4), 539-549.

Montana State University, B. (2018). Teaching Excellence Action Committee (TEACh). Retrieved from https://www.montana.edu/provost/committees/tlc.html

Montgomery College. (2017). Montgomery College Information Literacy Draft Standards and Expectations. Retrieved from https://cms.montgomerycollege.edu/uploadedFiles/EDU/Departments_-_Academic/General_Education_Program/General_Education_Subpages/MCInfoLit.pdf

Montgomery, K. (2000). Classroom rubrics: Systematizing what teachers do naturally. *The Clearing House, 73*(6), 324-328.

Moos, D. (2013). Examining hypermedia learning: The role of cognitive load and self-regulated learning. *Journal of Educational Multimedia and Hypermedia, 22*(1), 39-61.

Moskal, B. M. (2000). Scoring Rubrics: How? : ERIC Clearinghouse on Assessment and Evaluation, University of Maryland.

Mowen, J. C., & Cialdini, R. B. (1980). On implementing the door-in-the-face compliance technique in a business context. *Journal of Marketing Research*, 253-258.

Mulgrave, N., & Ducanis, A. (1975). Propensity to change responses in a Delphi round as a function of dogmatism in: Linstone and Turoff (Eds.) The Delphi method: techniques and applications. *Massachusetts Reading: Addison-Wesley*.

Murray, J. P. (1990). *The desired competencies for department chairpersons in a two-year college: A Delphi study.* The Ohio State University.

Murry, J. W., & Hammons, J. O. (1995). Delphi: A versatile methodology for conducting qualitative research. *The Review of Higher Education, 18*(4), 423.

National Center for Education Statistics. (2015). Table 5.1. Compulsory school attendance laws, minimum and maximum age limits for required free education, by state: 2015. Retrieved from https://nces.ed.gov/programs/statereform/tab5_1.asp

National Center for Educational Statistics. (2015). Nontraditional Undergraduates / Definitions and Data. Retrieved from http://nces.ed.gov/pubs/web/97578e.asp

National Center for Educational Statistics. (2016). Chapter 3: Postsecondary Education. Retrieved from https://nces.ed.gov/programs/digest/d14/ch_3.asp

Nielsen, J., & Molich, R. (1990). *Heuristic evaluation of user interfaces.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

No Child Left Behind Act of 2001, Pub. L. No. 107-110, Pub. L. No. Stat. 1425 § 115 (2001).

Norman, D. (1969). *The Delphi method: An experimental study of group opinion*. Retrieved from

O'Brien, D., & Scharber, C. (2008). Digital literacies go to school: Potholes and possibilities. *Journal of Adolescent & Adult Literacy, 52*(1), 66-68.

Ogbeifun, E., Agwa-Ejon, J., Mbohwa, C., & Pretorius, J. (2016). *The Delphi technique: A credible research methodology.* Paper presented at the Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management Kuala Lumpur, Malaysia.

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & management, 42*(1), 15-29.

Oxford English Dictionary. (2017). "ability, n.". Retrieved from http://www.oed.com/view/Entry/313?rskey=MDGypp&result=1

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational psychologist, 38*(1), 63-71.

Parsian, N., & Dunning, T. (2009). Developing and validating a questionnaire to measure spirituality: a psychometric process. *Global journal of health science, 1*(1), 2.

Pasukeviciute, I., & Roe, M. (2001). The politics of oil in Lithuania:: strategies after transition. *Energy policy, 29*(5), 383-397.

Pearson, G., & Garmire, E. (2006). Tech Tally: Approaches to Assessing Technological Literacy: National Academies Press.

Pearson, G., & Young, A. T. (2002). *Technically speaking: Why all Americans need to know more about technology*: National Academies Press.

Poll, H. (2015). *Pearson student mobile device survey 2015*. Retrieved from

Pollard, C., & Pollard, R. (2004). Research priorities in educational technology: A Delphi study. *Journal of Research on Technology in Education, 37*(2), 145-160.

Popham, W. J. (1997). What's wrong-and what's right-with rubrics. *Educational leadership, 55*, 72-75.

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon, 9*(5), 1-6. doi:doi:10.1108/10748120110424816

Prensky, M. (2012). *From digital natives to digital wisdom: Hopeful essays for 21st century learning*: Corwin Press.

Punch, K. F. (2013). *Introduction to social research: Quantitative and qualitative approaches*: sage.

Putman, J. W., Spiegel, A. N., & Bruininks, R. H. (1995). Future directions in education and inclusion of students with disabilities: A Delphi investigation. 553–576.

Quincy, J. (1840). *The History of Harvard University*.

Rader, H. B. (2002). Information literacy 1973-2002: A selected literature review. *Library trends, 51*(2), 242-259.

RAND. (2016). Delphi Method. Retrieved from http://www.rand.org/topics/delphi-method.html

Raskin, M. S. (1994). The Delphi study in field instruction revisited: Expert consensus on issues and research priorities. *Journal of Social Work Education, 30*(1), 75-89.

Rauch, W. (1979). The decision delphi. *Technological Forecasting and Social Change, 15*(3), 159-169.

Ravitch, S. M., & Riggan, M. (2016). *Reason & rigor: How conceptual frameworks guide research*: Sage Publications.

Ray, P. K., & Sahu, S. (1990). Productivity management in India: A Delphi study. *International Journal of Operations & Production Management, 10*(5), 25-51.

Rayens, M. K., & Hahn, E. J. (2000). Building consensus using the policy Delphi method. *Policy, politics, & nursing practice, 1*(4), 308-315.

Rea, L. M., & Parker, R. A. (2014). *Designing and conducting survey research: A comprehensive guide*: John Wiley & Sons.

Reddy, Y. M., & Andrade, H. (2010). A review of rubric use in higher education. *Assessment & Evaluation in Higher Education, 35*(4), 435-448.

Reh, J. (2016). Subject Matter Expert. Retrieved from https://www.thebalance.com/subject-matter-expert-2275099

Roberts, C. M. (2010). *The dissertation journey: A practical and comprehensive guide to planning, writing, and defending your dissertation*: Corwin Press.

Roberts, W. (2017). The Use of Cues in Multimedia Instructions in Technology as a way to Reduce Cognitive Load. *Journal of Educational Multimedia and Hypermedia, 26*(4), 373-412.

Roblyer, M., & Bennett, E. K. (2001). The fifth literacy: Research to support a mandate for technology-based visual literacy in preservice teacher education. *Journal of Computing in Teacher Education, 17*(2), 8-15.

Rochford, L., & Borchert, P. S. (2011). Assessing higher level learning: Developing rubrics for case analysis. *Journal of Education for Business, 86*(5), 258-265.

Rogers, M. R., & Lopez, E. C. (2002). Identifying critical cross-cultural school psychology competencies. *Journal of school psychology, 40*(2), 115-141.

Rohrbaugh, J. (1979). Improving the quality of group judgment: Social judgment analysis and the Delphi technique. *Organizational Behavior and Human Performance, 24*(1), 73-92.

Roscorla, T. (2015). Digital Education Provisions Tag Along in Senate Reauthorization Bill. Retrieved from http://www.centerdigitaled.com/k-12/Digital-Education-Provisions-Tag-Along-in-Senate-Reauthorization-Bill.html

Rosenblatt, S. (2010). They can find it but they don't know what to do with it: describing the use of scholarly literature by undergraduate students. *Journal of information literacy, 4*(2), 50-61.

Rowan College. (2017). Technology Literacy Rubric. Retrieved from https://www.rcgc.edu/Syllabi/Documents/CGA%20212.pdf#search=Technology%20Rubric

Rowe, G., & Wright, G. (1999). The Delphi technique as a forecasting tool: issues and analysis. *International journal of forecasting, 15*(4), 353-375.

Sackman, H. (1974). *Delphi assessment: Expert opinion, forecasting, and group process*. Retrieved from

Sadler, D. R. (2009). Indeterminacy in the use of preset criteria for assessment and grading. *Assessment & Evaluation in Higher Education, 34*(2), 159-179.

Saedi, D. (2003). Digital Global Literacy White Paper/Bylined Article. *10*.

Salancik, J., Wenger, W., & Helfer, E. (1971). The construction of Delphi event statements. *Technological Forecasting and Social Change, 3*, 65-73.

Savin-Baden, M., & Major, C. H. (2013). Qualitative research: The essential guide to theory and practice.

Scheibe, M., Skutsch, M., & Schofer, J. (1975). Experiments in Delphi methodology. *The Delphi method: Techniques and applications*, 257-281.

Schreiber, J. B. (2008). Pilot Study *The SAGE Encyclopedia of Qualitative Research Methods*: Sage Publications.

Schubert, M. A., & Borkman, T. (1994). Identifying the experiential knowledge developed within a self-help group. *Understanding the self-help organization. Thousand Oaks: Sage*.

Schwandt, T. A. (2007). *The Sage dictionary of qualitative inquiry*. United States of America: Sage Publications.

Seagle, E., & Iverson, M. (2002). Characteristics of the turfgrass industry in 2020: a Delphi study with implications for agricultural education programs. *Journal of Southern Agricultural Research, 52*(1), 1-13.

Seiter, E. (2008). Practicing at home: Computers, pianos, and cultural capital. *Digital youth, innovation, and the unexpected*, 27-52.

Selfe, C. L. (1999). *Technology and literacy in the 21st century: The importance of paying attention*: SIU Press.

Seybolt, R. F. (1917). *Apprenticeship & Apprenticeship Education in Colonial New England & New York: Robert Francis Seybolt*: Teachers college, Columbia university.

Shackelford, R. L., Brown, R., & Warner, S. A. (2004). Using concepts and theoretical models to support the standards for technological literacy. *Technology Teacher, 63*(5), 7-22.

Sharma, D. P., Nair, P. C., & Balasubramanian, R. (2003). Analytical search of problems and prospects of power sector through Delphi study: case study of Kerala State, India. *Energy policy, 31*(12), 1245-1255.

Shields, T., Silcock, G., Donegan, H., & Bell, Y. (1987). Methodological problems associated with the use of the Delphi technique. *Fire Technology, 23*(3), 175-185.

Singer, E., & Bossarte, R. M. (2006). Incentives for survey participation: When are they “coercive”? *American Journal of Preventive Medicine, 31*(5), 411-418.

Sivin-Kachala, J., & Bialo, E. R. (1994). *Report on the Effectiveness of Technology in Schools, 1990-1994*. Retrieved from

Skulmoski, G. J., Hartman, F. T., & Krahn, J. (2007). The Delphi method for graduate research. *Journal of information technology education, 6*, 1.

Slade, S. C., Dionne, C. E., Underwood, M., & Buchbinder, R. (2014). Standardised method for reporting exercise programmes: protocol for a modified Delphi study. *BMJ open, 4*(12), e006682.

Smith, C., Sadler, R., & Davies, L. (2015). Assessment rubrics. *GIHE, Griffith University*.

Smith, C. L. (2015). *Technology Literacy Skills Needed in Further Education and/or Work: A Delphi Study of High School Graduates’ Perspectives.* University of South Florida.

Snyder, T. D., de Brey, C., & Dillow, S. A. (2016). *Digest of education statistics 2015*: National Center for Education Statistics.

Spellings, M. (2006). *A test of leadership: Charting the future of US higher education*: US Department of Education.

Spinelli, T. (1983). The Delphi decision-making process. *The Journal of Psychology, 113*(1), 73-80.

State Educational Technology Directors Association [SETDA]. (2007). *2007 Technology Literacy Assessment and Educational Technology Standards Report*. Retrieved from http://www.setda.org/wp-content/uploads/2015/03/TEchnologyLiteracy2007Final.pdf

Stewart, J., O'Halloran, C., Harrigan, P., Spencer, J. A., Barton, J. R., & Singleton, S. J. (1999). Identifying appropriate tasks for the preregistration year: modified Delphi technique. *Bmj, 319*(7204), 224-229.

Tapio, P., Paloniemi, R., Varho, V., & Vinnari, M. (2011). The unholy marriage? Integrating qualitative and quantitative information in Delphi processes. *Technological Forecasting and Social Change, 78*(9), 1616-1628.

Tessmer, M. (1985). Information Literacy: A Working Definition. *American Libraries, 16*, 723.

Tyner, K. (2014). *Literacy in a digital world: Teaching and learning in the age of information*: Routledge.

U.S. Department of Education [DOE]. (2013). *Technology and engineering literacy framework for the 2014 National Assessment of Educational Progress*. Retrieved from

U.S. Department of Veterans Affairs. (2016). The Importance of Knowledge, Skills and Abilities (KSAs) Retrieved from http://www.vacareers.va.gov/application-process/navigating/ksas.asp

US Department of Education [DOE]. (1996). *Getting America's students ready for the 21st century: meeting the technology literacy challenge: a report to the Nation on Technology and Education*.

Vernon, W. (2009). The Delphi technique: A review. *International Journal of Therapy & Rehabilitation*, *16*(2).

Virkus, S. (2011). Information Literacy as an important competency for the 21st century: conceptual approaches. *Journal of the Bangladesh Association of Young Researchers (JBAYR)*, *1*(2), 15-29.

Visser, M. (2014). Digital Literacy Definition Retrieved from http://connect.ala.org/node/181197

von der Gracht, H. A. (2012). Consensus measurement in Delphi studies: review and implications for future quality assurance. *Technological Forecasting and Social Change, 79*(8), 1525-1536.

von der Gracht, H. A., & Darkow, I.-L. (2010). Scenarios for the logistics services industry: A Delphi-based analysis for 2025. *International Journal of Production Economics, 127*(1), 46-59.

Wagner College. (2017). Co-Curricular Competency: Information and Technological Literacy. Retrieved from http://wagner.edu/campus-life/files/2013/01/ITL.pdf

Waln, U. (2014). Creating Descriptive Rubrics for Educational Assessment. Retrieved from https://www.cnm.edu/.../assessment.../creating-descriptive-rubrics-for-educational-assessment.pptx

Wang, J., & Rairigh, R. M. (2006). Using Instructional Rubrics in Physical Education. *Teaching Elementary Physical Education, 17*(3), 37-41.

Washburn University. (2017). Standardized Assessment of Information Literacy Skills (SAILS). Retrieved from http://washburn.edu/mabee/strategic_plan/SAILS_PhaseIII.pdf

Waycott, J., Bennett, S., Kennedy, G., Dalgarno, B., & Gray, K. (2010). Digital divides? Student and staff perceptions of information and communication technologies. *Computers & education, 54*(4), 1202-1211.

Webber, S., & Johnston, B. (2000). Conceptions of information literacy: new perspectives and implications. *Journal of information science, 26*(6), 381-397.

Wegner, M. F. (2010). *Using the Delphi questionnaire technique to create a reading comprehension resource guide for middle school science teachers.* Walden University.

Weiss, J., Nolan, J., Hunsinger, J., & Trifonas, P. (2006). *The international handbook of virtual learning environments* (Vol. 14): Springer.

West, J. F., & Cannon, G. S. (1988). Essential collaborative consultation competencies for regular and special educators. *Journal of Learning Disabilities, 21*(1), 56-63.

Westbury, I. (1984). A nation at risk. *J. Curriculum Studies, 16*(4), 431-445.

Wiggins, G. (1998). *Educative Assessment*. San Francisco, CA.: Jossey-Bass.

Wilkinson, K. (2006). Students Computer Literacy: Perception Versus Reality. *Delta Pi Epsilon Journal, 48*(2).

Williams, P. L., & Webb, C. (1994). The Delphi technique: a methodological discussion. *Journal of advanced nursing, 19*(1), 180-186.

Wolsey, T. D., & Grisham, D. L. (2011). A Nation of Digital Immigrants: Four Principles. *California Reader, 44*(2).

Wonacott, M. E. (2001). *Technological literacy*: ERIC Clearinghouse on Adult Career and Vocational Education.

Wu-Rorrer, B. R. (2015). *STEM integration in middle school career and technical education programs: A Delphi design study.* University of Phoenix.

Young, J. (2004). Testing service to unveil an assessment of computer and information literacy. *The Chronicle of Higher Education, 51*, 12-33.

Young, J. A. (2012). *Forecasting twenty-first century information technology skills: A Delphi study*: Spalding University.

Yu, C. H. (2005). Reliability and validity. *Educational Assessment*, 2240-0524.

Yuan, M., & Recker, M. (2015). Not All Rubrics Are Equal: A Review of Rubrics for Evaluating the Quality of Open Educational Resources. *The International Review of Research in Open and Distributed Learning*, *16*(5).

Zimmermann, M., Darkow, I.-L., & Heiko, A. (2012). Integrating Delphi and participatory backcasting in pursuit of trustworthiness—the case of electric mobility in Germany. *Technological Forecasting and Social Change, 79*(9), 1605-1621.

Zinn, J., Zalokowski, A., & Hunter, L. (2001). Identifying indicators of laboratory management performance: a multiple constituency approach. *Health Care Management Review*, *26*(1), 40-53.

Zorn, T., Christensen, L. T., & Cheney, G. (1999). Do we really want constant change?

APPENDICES

APPENDIX A

DIGITAL LITERACY DEFINITIONS

Digital Literacy Definitions

Source	**Definition – Digital Literacy**
(Gilster, 1997, p.1)	the ability to understand information and use information in multiple formats from a wide range of sources when it is presented via computers.
(Holum & Gahala, 2001)	the ability to attain deeper understanding of content by using data-analysis tools and accelerated learning processes enabled by technology
(Saedi, 2003)	a means for ascertaining the competency of an individual to function in the workplace
(Martin, 2005, pg.135)	the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process
(Buckingham, 2006, pg.265)	a minimal set of technical skills that enabled users of technology to operate effectively and to perform basic tasks.
(Jones & Flannigan, 2006)	a person’s ability to perform tasks effectively in a digital environment, with the term “digital” meaning information represented in numeric form and primarily for use by a computer. Literacy includes the ability to read and interpret media (text, sound, images, et. al.), to reproduce data and images through digital manipulation, and to evaluate and apply new knowledge gained from digital environments.
(Martin, 2006, pg.19)	is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analysis and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process.

(Martin & Grudziecki, 2006, p. 255)	the awareness, attitude and ability of individuals' to use digital tools for communication, expression and social action in specific life situations.
(O'Brien & Scharber, 2008, pg. 66-67)	Socially situated practices supported by skills, strategies and stances that fostered an individual's ability to represent and understand ideas with numerous modalities and digital tools
EU Digital Literacy: Skills for the Information Society, http://ec.europa.eu/ information_society/tl/edutra/skills/index_en.htm (accessed January31, 2010)	involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.
(Hobbs, 2010, pg. vii)	as a constellation of life skills that are necessary for full participation in our media-saturated, information-rich society.
(Hague & Payton, 2011)	access to a broad range of practices and cultural resources that you are able to apply to digital tools. It is the ability to make and share meaning in different modes and formats; to create, collaborate and communicate effectively and to understand how and when digital technologies can best be used to support these processes.
(Littlejohn et al., 2012, p. 547)	means the capabilities required to thrive in and beyond education, in an age when digital forms of information and communication predominate.
(Visser, 2014)	the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills.
California ICT Digital Literacy Assessments and Curriculum Framework pg 3	ability to use digital technology and communications tools, and/or networks to access, manage, integrate, evaluate, create and communicate information in order to function in a knowledge society.

APPENDIX B

INFORMATION LITERACY DEFINITIONS

Information Literacy Definitions

Source	Definition – Information Literacy
(Tessmer, 1985)	is the ability to effectively access and evaluate information for a given need
(American Library Association, 1989, pg. 3)	skills that enable an individual to use computers, software applications, databases, and other technologies to achieve a wide variety of academic, work-related, and personal goals
(ALA, 1989)	the ability to recognize when information is needed and the ability to locate, evaluate, and use the needed information effectively.
(Breivik & Gee, 1989)	is the ability to effectively access and evaluate information for a given need. It includes an integrated set of skills (research strategy and evaluation) and knowledge of tools and resources.
(Dyrenfurth & Kozak, 1991, pg 139)	A concept used to characterize the extent to which an individual understands, and is capable of using technology
(Doyle, 1992, pg 3) Delphi Method derived definition	is the ability to access, evaluate, and use information from a variety of sources
(Fortier et al., 1998, pg 1)	is the ability of an individual, working independently or with others, to use tools, resources, processes, and systems responsibly to access and evaluate information in any medium, and to use that information to solve problems, communicate clearly, make informed decisions, and construct new knowledge, products, or systems.
([ACRL] Association of College Research Libraries, ,, 2000)	a set of abilities requiring individuals to recognize when information is needed and

	have the ability to locate, evaluate, and use effectively the needed information
([ACRL] Association of College Research Libraries, ., 2000)	the set of skills to access, evaluate, organize, and use information from a variety of sources
(ACRL Association of College Research Libraries, ., 2000, pg 2)	a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.
(Holum & Gahala, 2001)	the ability to access and use information, analyze content, work with ideas, synthesize thought, and communicate results
(Koning, 2001)	as locating, evaluating, managing, and using information effectively from a range of sources for problem solving, decision making, and research
(ICT Literacy, 2002, pg 16)	ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society.
Association of College & Research Libraries (2003)	a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the information needed.
(Johnston & Webber, 2003)	is the adoption of appropriate information behavior to obtain, through whatever channel or medium, information well fitted to information needs, together with critical awareness of the importance of wise and ethical use of information in society.

APPENDIX C

TECHNOLOGY LITERACY DEFINITIONS

Technology Literacy Definitions

Source	**Definition – Technology Literacy**
(Dyrenfurth & Kozak, 1991, pg 179)	a concept used to characterize the extent to which an individual understands, and is capable of using, technology. Technological literacy is a characteristic that can be manifested along a continuum ranging from non-discernible to exceptionally proficient. As such, it necessarily involves an array of competencies, each best thought of as a vector, that include: Basic functional skills and critical thinking, constructive work habits, a set of generalized procedures for working with technology, actual technological capability, key interpersonal and teamwork skills, and the ability to learn independently.
(US Department of Education [DOE], 1996)	Computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic
(US Department of Education [DOE], 1996, pg 5)	the ability to use computers and other technology to improve learning, productivity, and performance
(McMillan, 1996)	the knowledge and ability a person has to use computers.
(Dugger, 1997)	the ability to use, manage and understand technology
(Selfe, 1999, pg 11)	a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.
([ACRL] Association of College Research Libraries, ,, 2000)	rote learning of specific hardware and software applications.

(Leu & Kinzer, 2000)	the ability to gather, organize, analyze, and report information using technology.
(Dugger Jr, 2001, pg 514)	is the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.
(International Technology Education Association [ITEA], 2003)	the ability to use, manage, assess, and understand technology.
(Hansen, 2003, pg 117)	an individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment
(Shackelford et al., 2004, pg 7)	design, develop, control, use and assess technological systems and processes
(International Society for Technology in Education [ISTE], 2007b)	the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.
(Colorado Department of Education, 2009)	the ability to responsibly use appropriate technology to: • Communicate • Solve problems • Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas • Acquire lifelong knowledge and skills in the 21st century

APPENDIX D

STATE ADOPTED TECHNOLOGY LITERACY DEFINITIONS

State Adopted Technology Literacy Definitions

State	Organization	Definition
Alabama	ISTE NETS	
Alaska	Unique State Definition	Technology literacy and proficiency is the ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills.
Arizona	Unique State Definition	Ability to responsibly use appropriate technology to communicate, solve problems, create products and access, manage, integrate, evaluate, and create information to improve learning in all subjects, to use information to improve learning.
Arkansas	ISTE NETS	
California	Unique State Definition	Ability to responsibly use appropriate technology to communicate, solve problems, and access, create, integrate, evaluate, and manage information to improve learning of state content standards in all subject areas and to acquire lifelong knowledge and skills in the 21st century.
Colorado	Other	SETDA definition with minor modifications
Connecticut	ISTE NETS	
Delaware	SETDA	
D.C.	ISTE NETS	
Florida	SETDA	Florida Technology Literacy Profile: Ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century. http://www.fldoe.org/BII/Instruct_Tech/downloads/FLTechLiteracyProfile.pdf

Georgia	Unique State Definition	Ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.
Hawaii	ISTE NETS	
Idaho	ISTE NETS	
Illinois	Unique State Definition	Technology literate is the ability to contribute effectively in a global society through the appropriate use of technology to solve problems, to communicate, to collaborate, and to connect information, ideas, and learning.
Indiana	SETDA	
Iowa	Other	Defined by each district supported by the Area Education Agency.
Kansas	SETDA	
Kentucky	ISTE NETS	
Louisiana	ISTE NETS	
Maine	SETDA	
Maryland	Unique State Definition	Technology literacy is defined as the ability of an individual, working independently and with others, to responsibly, appropriately and effectively use technology tools to access, manage, integrate, evaluate, create and communicate information.
Massachusetts	Unique State Definition	Three broad standards: Basic Operations, Concepts, and Productivity Tools; Digital Citizenship, Ethics, Society, and Safety; and Research and Information Fluency; Critical Thinking, Problem Solving & Decision Making; Communication and Collaboration; and Creativity and Innovation. http://www.doe.mass.edu/edtech/standards/itstand_draft.doc

Michigan	Unique State Definition	Technology literacy is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge.
Minnesota	ISTE NETS	
Mississippi	ISTE NETS	
Missouri	SETDA	
Montana	Other	The state uses TAGLIT as a measurement devise with a score of "3" or better indicating literacy.
Nebraska	ISTE NETS	
Nevada	ISTE NETS	
New Hampshire	Unique State Definition	ICT Literacy Standards describe a K-12 program for all public schools. ICT is integrated with core content, students create digital portfolios, 8th grade portfolios are assessed, and 1/2 credit of ICT is required for graduation. http://www.nheon.org/oet/standards/ICTquickref.pdf
New Jersey	Unique State Definition	All students will use computer applications to gather and organize information and to solve problems. http://education.state.nj.us/cccs/?_standard_matrix;c=8
New Mexico	ISTE NETS	
New York	Other	Technology literacy is: 1. An understanding of the concepts behind computing equipment, network connectivity, and application software; 2. The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and 3. The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace.
North Carolina	ISTE NETS	

North Dakota	Unique State Definition	North Dakota has used its Library/Technology Literacy standards: research, developing products using media/technology, technological systems, collaborative skills/independent learning/personal enjoyment, and ethical, legal, and social usage http://www.dpi.state.nd.us/standard/content/tech.pdf
Ohio	Unique State Definition	Achievement of State of Ohio Technology Academic Content Standards. Seven standards: Nature of Technology; Technology and Society Interaction; Technology for Productivity Applications; Technology and Communication Applications; Technology and Information Literacy; Design; and Designed World http://www.ode.state.oh.us/GD/Templates/Pages/ODE/ODEDetail.aspx?page=3&TopicRelationID=339&ContentID=1279&Content=32802
Oklahoma	ISTE NETS	
Oregon	SETDA	The Oregon Educational Technology Evaluation Task Force if reviewing the definition of technology literacy in light of the release of the ISTE NETS for Students and the new State Board revisions to high school diploma requirements.
Pennsylvania	ISTE NETS	Pennsylvania has not formally adopted a Technology Literacy definition; however, for the purposes of EETT, PA requires that LEA adopt local standards that meet or exceed the ISTE NETS.
Rhode Island	ISTE NETS	
South Carolina	ISTE NETS	
South Dakota	Unique State definition	Learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.
Tennessee	ISTE NETS	

Texas	Other	Technology literacy is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge.
Utah	ISTE NETS	
Vermont	ISTE NETS	
Virginia	Unique State Definition	The possession and use of technology skills to communicate, solve problems, and access, create, integrate, evaluate, and manage information to improve the learning of state content standards in all subject areas and to acquire lifelong knowledge.
Washington	Unique State Definition	Ability to responsibly, creatively, & effectively use appropriate technology to: communicate; access, collect, manage, integrate, & evaluate information; solve problems & create solutions; build & share knowledge; and improve & enhance learning.
West Virginia	ISTE NETS/SETDA	A combination of both the ISTE and SETDA definitions.
Wisconsin	SETDA	
Wyoming	ISTE NETS	The State does have a unique definition of technology literacy, however the State also used the ISTE NETS definition to fine tune the State definition.

APPENDIX E

SCOPUS ANALYSIS OF DELPHI METHOD RESEARCH USAGE – 1968-2016

Scopus Analysis of Delphi Method Research Usage – 1968-2016

Scopus Analysis-Year	
Query keyword: Delphi method	
Number of results: 8619	
YEAR	#
2016 (6 months)	587
2015	1003
2014	977
2013	846
2012	716
2011	683
2010	588
2000-2009	2373
1990-1999	551
1980-1989	163
1970-1979	123
1968-1969	9

Scopus Analysis-DOCUMENT TYPE		
Query keyword: Delphi method		
Number of results: 8619		
DOCUMENT TYPE	#	%
Article	6483	75.2%
Conference Paper	1217	14.1%
Review	597	6.9%

Article in Press	201	2.3%
Book Chapter	50	0.6%
Conference Review	19	0.2%
Editorial	17	0.2%
Letter	14	0.2%
Note	9	0.1%
Short Survey	7	0.1%
Book	3	0.1%
Erratum	1	0.0%
Report	1	0.0%

Scopus Analysis: Subject Area		
Query keyword: Delphi method		
Number of results: 8619		
SUBJECT AREA	#	%
Medicine	4312	50.0%
Engineering	1387	16.1%
Social Sciences	1044	12.1%
Computer Science	887	10.3%
Business, Management and Accounting	795	9.2%
Nursing	693	8.0%
Environmental Science	471	5.5%
Health Professions	402	4.7%
Biochemistry, Genetics and Molecular Biology	332	3.9%
Agricultural and Biological Sciences	311	3.6%
Psychology	287	3.3%
Decision Sciences	283	3.3%
Mathematics	253	2.9%
Physics and Astronomy	217	2.5%
Pharmacology, Toxicology and Pharmaceutics	198	2.3%
Earth and Planetary Sciences	195	2.3%
Economics, Econometrics and Finance	176	2.0%
Immunology and Microbiology	173	2.0%
Energy	157	1.8%

Neuroscience	99	1.1%
Arts and Humanities	91	1.1%
Materials Science	81	0.9%
Multidisciplinary	71	0.8%
Dentistry	59	0.7%
Chemical Engineering	57	0.7%
Chemistry	44	0.5%
Veterinary	29	0.3%
Undefined	59	0.7%

APPENDIX F

INVITATION EMAIL – SINGLE HEURISTIC EVALUATION

Dear___________,

Thank you for your willingness to participate in this heuristic evaluation of technology literacy definitions. You are being asked to evaluate 26 technology literacy definitions, identifying approximately the top the definitions using three heuristics as a guide. Once your responses have been analyzed, they will be used as the first part of a modified Delphi methods study.

Please read, digitally sign and return the attached informed consent form.

Please complete this survey by February 8th, 5:00 p.m.

Notes on saving your responses – continuing at a later time/date.

The survey is designed to allow you to save and continue. To save and continue, scroll to the bottom of the survey and select the box with the arrow pointing to the right. Selecting this button will save your responses. To return to your partially completed survey use the same link (below) used to enter the survey the first time. For this function to work your cookies must be active. If your cookies are turned off, the save and continue function will not work requiring the completion of the survey in one sitting.

Please contact me if you have any questions.

Thank you for your participation in this study.

APPENDIX G

CONSENT FORM – SINGLE HEURISTIC EVALUATION

SUBJECT CONSENT FORM
FOR
PARTICIPATION IN HUMAN RESEARCH AT
MONTANA STATE UNIVERSITY

ATLAS – Academic Technology Literacy ASsessment: A Technology Literacy Modified Delphi Method Study
You are being asked to participate in the first part of a four-part research study being conducted to identify exemplary technology literacy definitions from current technology literacy definitions, develop a basic academic technology literacy rubric and identify steps needed to implement the rubric system at the program, department, college and university level. Currently, definitions specific to technology literacy are diluted to be used to define not only technology literacy, but also information(al), digital and media literacies. With a list of specific exemplary technology literacy definition evaluated, and selected by experts, individuals and/or groups will have a list of exemplary technology literacy definitions vetted by experts that can be selected to suit their situation.

You have been selected to participate in part one of this study because of your knowledge of higher education academics, technology integration into higher education classrooms, and how students use integrated technology in the classrooms. **Participation in part one of this study is voluntary, you can choose to not answer any questions you do not want to answer and/or you can stop at anytime. If you agree to participate in part one of this four-part research study you will be asked to** participate in a single Heuristic Evaluation reducing 26 technology literacy definitions, which are currently being used in the literature down to 10. These 10 definitions will be included as part of the modified Delphi method study. You will be contacted via e-mail with a link to the survey that contains the pre and post survey instructions as well as the survey itself. Participation in part one of this research study will be of no cost to you, and no compensation for participation in part one will be offered. Participation in part one is scheduled to take seven days, and your participation is a single occurrence. The responses to the single heuristic evaluation will remain confidential for the duration of this study, and will only be known by the researcher. Responses of the survey will be stored securely on the Qualtrics server and researcher's personal computer, both of which are password protected with the password known only by the researcher. Data for the survey will be deleted from the Qualtrics server at the completion of the dissertation, and after five years on the researcher's personal computer.

As a participant in this study, there are no anticipated risks associated with your participation in this study. While there are no direct benefits to you for your participation, indirectly you will be advancing this study by providing your expert evaluation and selection of exemplary technology literacy definitions.

If you have any questions that arise during or after your participation in this study, you are encouraged to contact me at [redacted], or by e-mail at [redacted] If you have any questions or concerns regarding this study and would like to talk with someone other than the researcher, you are encouraged to contact [redacted], the chair of Montana State Universities Institutional Review Board at [redacted]

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I, ______________________________ *(name of subject),* agree to participate in this research. I understand that I may later refuse to participate, and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

Signed: ____

Witness: ____ (optional)

Investigator: ____

Date: ____

APPENDIX H

SINGLE HEURISTIC EVALUATION INSTRUMENT

Single Heuristic Evaluation

Start of Block: HE-Technology Literacy Definitions

1 **Heuristic Evaluation of Technology Literacy Definitions** Thank you for your willingness to participate in this Heuristic Evaluation of technology literacy definitions. As mentioned in the consent form, your participation in this evaluation is voluntary, you can choose to not answer any questions you do not want to answer and/or you can stop at anytime. The purpose of this heuristic evaluation is to reduce the 26 technology literacy definitions identified in the literature. The goal of the heuristic evaluation is to identify approximately ten exemplary technology literacy definitions. The first part of this survey asks you to provide some demographic information. Once you have completed the demographic section, proceed to the heuristic evaluation.

Read each definition and evaluate the definition as to how it meets each of the heuristic criteria. If a definition meets all three of the heuristics, select all three boxes check marks, two of the heuristics select the appropriate boxes, one of the heuristics check the appropriate box and select the last box if none of the heuristic criteria were met. For example, if a definition meets all three heuristics, all three boxes will have check marks.
Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest.

Minimal language redundancy: The technology literacy definition should minimize redundancy in its language.

Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology.

2 **Demographics**

3 What is your gender?

- O Male (1)
- O Female (2)
- O Other (3)

4 What is your age

- O Under 18 (1)
- O 18 - 24 (2)
- O 25 - 34 (3)
- O 35 - 44 (4)
- O 45 - 54 (5)
- O 55 - 64 (6)
- O 65 - 74 (7)
- O 75 - 84 (8)
- O 85 or older (9)

5 What is the highest degree or level of school you have completed?

- O Less than a high school diploma (1)
- O High school degree or equivalent (e.g. GED) (2)
- O Some college, no degree (3)
- O Associate degree (e.g. AA, AS) (4)
- O Bachelor’s degree (e.g. BA, BS) (5)
- O Master’s degree (e.g. MA, MS, MEd) (6)
- O Professional degree (e.g. MD, DDS, DVM) (7)
- O Doctorate (e.g. PhD, EdD) (8)

6 What is the title of your current position?

- O Instructor (1)
- O Assistant Professor (2)
- O Associate Professor (3)
- O Full Professor (4)
- O Non-Tenure Track (5)
- O Adjunct (6)
- O Professional Staff (7)
- O Other (8)

7 Number of years working in Higher Education?

- O 1-5 (1)
- O 5-10 (2)
- O 10-15 (3)
- O 15-20 (4)
- O 20-25 (5)
- O Over 25 (6)

---

8 What level would you rate your overall technology literacy/knowledge at - digital and non-digital?

- O Novice (1)
- O Advanced Beginner (2)
- O Competent (3)
- O Proficent (4)
- O Expert (5)

---

9 **Heuristic Evaluation**

Read each definition and evaluate the definition as to how it meets each of the heuristic criteria. If a definition meets all three of the heuristics, select all three boxes check marks, two of the heuristics select the appropriate boxes, one of the heuristics check the appropriate box and select the last box if none of the heuristic criteria were met.

---

10 A concept used to characterize the extent to which an individual understands, and is capable of using, technology. Technological literacy is a characteristic that can be manifested along a continuum ranging from non-discernible to exceptionally proficient. As such, it necessarily involves an array of competencies, each best thought of as a vector, that include: Basic functional skills and critical thinking, constructive work habits, a set of generalized procedures for working with technology, actual technological capability, key interpersonal and teamwork skills, and the ability to learn independently.

- ▢ Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest. (1)
- ▢ Minimal language redundancy: The technology literacy definition should minimize redundancy in its language. (2)
- ▢ Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (3)
- ▢ No heuristic criteria met (4)

---

11 Computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic

- ▢ Engagement: (1)
- ▢ Minimal language redundancy: (2)
- ▢ Human-centric syntax: (3)
- ▢ No heuristic criteria met (4)

---

12 The ability to use computers and other technology to improve learning, productivity, and performance.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

13 The knowledge and ability a person has to use computers.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

14 The ability to use, manage and understand technology

- ☐ Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners’ interest. (1)
- ☐ Minimal language redundancy: The technology literacy definition should minimize redundancy in its language. (2)
- ☐ Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (3)
- ☐ No heuristic criteria met (4)

---

15 The ability to use, manage, assess, and understand technology.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

16 A complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

17 Rote learning of specific hardware and software applications.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

18 The ability to gather, organize, analyze, and report information using technology.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

19 Is the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.

- ☐ Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest. (1)
- ☐ Minimal language redundancy: The technology literacy definition should minimize redundancy in its language. (2)
- ☐ Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (3)
- ☐ No heuristic criteria met (4)

---

20 An individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

21 Design, develop, control, use and assess technological systems and processes

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

22 The ability to responsibly use appropriate technology to: · Communicate · Solve problems · Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas · Acquire lifelong knowledge and skills in the 21st century

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

23 The ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to

improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.

- ▢ Engagement: (1)
- ▢ Minimal language redundancy: (2)
- ▢ Human-centric syntax: (3)
- ▢ No heuristic criteria met (4)

---

24 The ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills.

- ▢ Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest. (1)
- ▢ Minimal language redundancy: The technology literacy definition should minimize redundancy in its language. (2)
- ▢ Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (3)
- ▢ No heuristic criteria met (4)

---

25 Ability to responsibly use appropriate technology to communicate, solve problems, create products and access, manage, integrate, evaluate, and create information to improve learning in all subjects, to use information to improve learning.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

26 Ability to responsibly use appropriate technology to communicate, solve problems, and access, create, integrate, evaluate, and manage information to improve learning of state content standards in all subject areas and to acquire lifelong knowledge and skills in the 21st century.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

27 Ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.

- Engagement: (1)
- Minimal language redundancy: (2)
- Human-centric syntax: (3)
- No heuristic criteria met (4)

---

28 Ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.

- Engagement: (1)
- Minimal language redundancy: (2)
- Human-centric syntax: (3)
- No heuristic criteria met (4)

---

29 The ability to contribute effectively in a global society through the appropriate use of technology to solve problems, to communicate, to collaborate, and to connect information, ideas, and learning.

- ☐ Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest. (1)
- ☐ Minimal language redundancy: The technology literacy definition should minimize redundancy in its language. (2)
- ☐ Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (3)
- ☐ No heuristic criteria met (4)

---

30 is defined as the ability of an individual, working independently and with others, to responsibly, appropriately and effectively use technology tools to access, manage, integrate, evaluate, create and communicate information.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

31 is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

32 Technology literacy is: · An understanding of the concepts behind computing equipment, network connectivity, and application software; · The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and · The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace.

- ☐ Engagement: (1)
- ☐ Minimal language redundancy: (2)
- ☐ Human-centric syntax: (3)
- ☐ No heuristic criteria met (4)

---

33 The possession and use of technology skills to communicate, solve problems, and access, create, integrate, evaluate, and manage information to improve the learning of state content standards in all subject areas and to acquire lifelong knowledge.

- [ ] Engagement: The technology literacy definition should engage and motivate the intended audience of learners. It should stimulate learners' interest. (1)
- [ ] Minimal language redundancy: The technology literacy definition should minimize redundancy in its language. (2)
- [ ] Human-centric syntax: The technology literacy definition should use the human-centric syntax (designed to be easily understood). The technology literacy definition should be easily readable and avoid obscure terminology. (3)
- [ ] No heuristic criteria met (4)

---

34 Ability to responsibly, creatively, & effectively use appropriate technology to: communicate; access, collect, manage, integrate, & evaluate information; solve problems & create solutions; build & share knowledge; and improve & enhance learning.

- [ ] Engagement: (1)
- [ ] Minimal language redundancy: (2)
- [ ] Human-centric syntax: (3)
- [ ] No heuristic criteria met (4)

---

35 Comments

____

APPENDIX I

COSMIN CHECKLIST

The Development and Validation of Questionnaires

The work entailed in reporting cases must be a worthwhile contribution to well-designed studies that will not make excessive demands on the time and goodwill of its respondents. Therefore, questionnaires should be as brief, simple, attractive and "user friendly" as possible.

Does this questionnaire identify the variables of interest? How will each of these variables be analyzed?

Is a questionnaire the most appropriate way of collecting this data?

Will these questions enable the researchers to distinguish between rival hypothesis relating to the research questions?

Has the questionnaire been piloted sufficiently (Usually 5-10% of sample)?

What steps have been taken to measure the reliability and validity of this questionnaire and are the measurements sufficient?

Is the length of time to complete the questionnaire acceptable? (In all but exceptional cases this should be 10-15 minutes maximum.)

Will the respondent have access to all the information required to complete the questionnaire? If not are the steps required to obtain that information acceptable (e.g. Asking the patient for a return appointment)

Are any questions unnecessary, repetitive or inappropriate?

Are filter questions clear and employed appropriately?

Are the sections/ questions in a logical order?

Is the layout compact, not crammed, and attractive?

Are closed responses and layout standardized wherever possible?

Are all questions worded in a clear, concise and unambiguous manner? Are the instructions meaningful and easy to follow?

Have the recommendations and conditions specified in the application guidelines been followed?

Is the protocol for sending out reminders and additional copies of the questionnaire both sufficient and acceptable?

APPENDIX J

MODIFIED DELPHI METHOD STUDY INVITATION EMAIL

Good morning [redacted],

My name is Steve Luft. I am currently a doctoral candidate in the Adult and Higher Education program at Montana State University. I am looking for individuals to participate in a three-round modified Delphi method study.

Currently, I am in the process of identifying exemplary technology literacy definitions from current technology literacy definitions and developing a Basic Academic Technology Literacy Rubric (BATLR). The significance of this study looks at technology literacy definitions and basic academic technology literacy skills with a pragmatic approach. The first part of this study is to gain a better understanding of the current technology literacy definitions. The second part of the study is to develop a basic academic technology literacy skills rubric. This study will also create a mechanism for students, faculty, and anyone associated with basic academic technology literacy skills to assess their current skill level and what is required to move to the next level. This rubric could also be used by faculty to set specific course outcomes and provide students the framework to successfully meet those outcomes.

To achieve the goals of this study, I would like to ask you to contribute your expert knowledge and opinion as a Subject Matter Expert (SME) participant in the area of Introduction to Computers and Microsoft Office. You are being asked to participate in a three-round modified Delphi method study. A modified Delphi method study is a research method used to gain consensus of expert opinions through multiple rounds of structured communication. You will also be asked to pair general computer, word processing, spreadsheet, database, presentation and email communication skills with their appropriate novice, advanced beginner, competent, proficient and expert skill level. The first round is estimated to take 20-30 minutes with round two taking less time and round three taking the least amount of time.

The responses you provide will remain confidential for the duration of this study, and will only be known by the researcher. Responses to the survey will be stored securely on the Qualtrics server and researcher’s personal computer, both of which are password protected with the password known only by the researcher. Data for the survey will be deleted from the Qualtrics server at the completion of the dissertation, and after five years on the researcher’s personal computer. As a participant in this study, there are no anticipated risks associated with your participation in this study. Except for the incentive for participation, there are no direct benefits to you for your participation, but indirectly you will be advancing this study by providing your expert evaluation.

In appreciation for your participation in this study, participants that **complete all three rounds** of this modified Delphi method study will receive a **$50.00 electronic Amazon gift card** upon the completion of the modified Delphi methods study.

Please reply to this email by typing one of the following responses in the Subject line:
Yes, I would like to participate in this study.
OR
No, I do not want to participate in this study.

If you have any questions before or after committing, please feel free to contact me. Thank you for your time and consideration for participating in this study.

Sincerely,
Steve

APPENDIX K

MODIFIED DELPHI METHOD STUDY INSTRUMENT

Modified Delphi Method Study

Q1
SUBJECT CONSENT FORM
FOR
PARTICIPATION IN HUMAN RESEARCH AT
MONTANA STATE UNIVERSITY
Technology Literacy: A Modified Delphi Method Study to Identify Exemplary Technology Literacy Definitions, Develop a Basic Academic Technology Literacy Rubric (BATLR) and methods of integration.

You have been selected to participate in the third part of a four-part research study being conducted to identify exemplary technology literacy definitions from current technology literacy definitions and develop a basic academic technology literacy rubric. **Participation in part three of this study is voluntary, you can choose to not answer any questions you do not want to answer and/or you can stop at anytime. If you agree to participate in part three of this four-part research study you will be asked to** participate in this modified Delphi method study.

Participation in part three of this research study will be of no cost to you. For your participation in this study, you will be compensated for participation in part three of this study. Participants that **complete all three rounds** of this modified Delphi method study **will receive a $50.00 electronic Amazon gift card**. Participants will be given seven days to complete each round of the survey. The responses will remain confidential for the duration of this study, and will only be known by the researcher. Responses of the survey will be stored securely on the Qualtrics server and researcher's personal computer, both of which are password protected with the password known only by the researcher. Data for the survey will be deleted from the Qualtrics server at the completion of the dissertation, and after five years on the researcher's personal computer.

As a participant in this study, there are no anticipated risks associated with your participation in this study. While there are no direct benefits to you for your participation, but indirectly you will be advancing this study by providing your expert evaluation.

If you have any questions that arise during or after your participation in this study, you are encouraged to contact me at [redacted], or by e-mail at [redacted]. If you have any questions or concerns regarding this study and would like to talk with someone other than the researcher, you are encouraged to contact [redacted]

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I agree to participate in this research. I understand that I may later refuse to participate, and that I may withdraw from the study at any time. I may, at any time, request a copy of this consent form for my own records.

By proceeding, you agree that you understand the nature of the study, the possible risks to you as a participant, and how your identity will be kept confidential. By proceeding to the next page, this means that you are 18 years old or older and that you give your permission to volunteer as a participant in the study that is described here.

Q2 I understand that my participation in this study is voluntary and I may withdraw from this study at any time without consequences.
Yes (1)
No (2)

Q3 I understand that any personal information collected during this study will remain confidential, secure on a password protected computer/locked in a secure cabinet for the duration of this study, and five years beyond, which at this time it will be destroyed.
Yes (1)
No (2)

Q4 I understand that there are no anticipated risks in participating in this study.
Yes (1)
No (2)

Q5 I understand that I may contact the researcher at any time to ask questions regarding this study.
Yes (1)
No (2)

Q8 **General Survey Notes and Instructions**

Thank you for agreeing to take part in this modified Delphi methods study survey. This survey is divide into three primary sections. The first section is the participants demographics section, collecting general demographics. The second section is the identification of exemplary technology literacy definition(s). The third section is the pairing of basic academic technology literacy skills with the appropriate Dreyfus Skill Acquisition level.

This modified Delphi method study utilizes a three round iterative structure formatted in a Likert scale structure. The first question will ask participants to rate exemplary technology literacy definitions. The second question participants will be asked to pair basic academic technology literacy skills in computer, word processing, spreadsheet, Database, presentation, and email/communication skills with the appropriate Dreyfus Skill Acquisition level: novice, advanced beginner, competent, proficient and expert skill levels.

The goal of the modified Delphi method study is to reach a consensus level of 80% for each question over the course of three rounds. Responses that meet the 80% consensus cut-off value in each round will be added to the exemplary technology literacy definition list and basic academic technology literacy rubric. Items that did not meet the consensus cut-off value will be compiled and formatted for the next round after feedback from participants is reviewed.

The first round of the modified Delphi method study is projected to take the most time, approximately20 - 30 minutes. Once 80% consensus is reached for a question, it is removed from the survey, hence reducing the number of questions and time needed to complete rounds two and three. In rounds two and three, the questions that did not reach an 80% consensus are the only questions that you will be asked to respond to. At the completion of each round, you will be provided feedback. Each round will be available for seven days to complete with a reminder being sent out on the fourth day.

This survey is designed to allow you to save and continue later. To save, scroll to the bottom of the survey and select the box with the arrow pointing to the right. Selecting this button will save your responses. To return to your partially completed survey use the same link (the one emailed to you) used to enter the survey the first time. For the save function to work your cookies must be active. If your cookies are turned off, the save and continue function will not work requiring the completion of the survey in one sitting.

Q9 **Participant Demographics**

Q10 What is your gender?
Male (1)
Female (2)
Other (3)

Q11 What is your age
Under 18 (1)
18 - 24 (2)
25 - 34 (3)
35 - 44 (4)
45 - 54 (5)
55 - 64 (6)
65 - 74 (7)
75 - 84 (8)
85 or older (9)

Q12 What is the highest degree or level of school you have completed?
Less than a high school diploma (1)
High school degree or equivalent (e.g. GED) (2)
Some college, no degree (3)
Associate degree (e.g. AA, AS) (4)
Bachelor’s degree (e.g. BA, BS) (5)
Master’s degree (e.g. MA, MS, MEd) (6)
Professional degree (e.g. MD, DDS, DVM) (7)
Doctorate (e.g. PhD, EdD) (8)

Q13 What is the title of your current position?
Instructor (1)
Assistant Professor (2)
Associate Professor (3)
Full Professor (4)
Non-Tenure Track (5)
Adjunct (6)
Professional Staff (7)
Other (8)

Q14 Number of years working in Higher Education?
1-5 (1)
5-10 (2)
10-15 (3)
15-20 (4)
20-25 (5)
Over 25 (6)

Q15 What level would you rate your overall technology literacy/knowledge at - digital and non-digital?
Novice (1)
Advanced Beginner (2)
Competent (3)
Proficient (4)
Expert (5)

Q16 **Technology Literacy Definition Rating**

This section of the survey asks you to rate each technology literacy definition from excellent to poor. These definitions come from a list of technology literacy definitions reduced down from 26 to ten by the use of a heuristic evaluation conducted earlier. Once a question has reached an 80% consensus level, it is removed from the surveys subsequent rounds. Feedback for each round will be provided for confirmation/clarification before the next round.

Q17 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic. (1)				

Q18 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
the ability to responsibly use appropriate technology to: Communicate Solve problems Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas Acquire lifelong knowledge and skills in the 21st century (1)				

Q19 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
an individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment. (1)				

Q20 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
An understanding of the concepts behind computing equipment, network connectivity, and application software; The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace. (1)				

Q21 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society. (1)				

Q22 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating. (1)				

Q23 Technology literacy ...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)

and proficiency is the ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills. (1)				

Q24 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
the ability to gather, organize, analyze, and report information using technology. (1)				

Q25 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)

the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century. (1)

Q26 Technology literacy is...

	Excellent (1)	Good (2)	Fair (3)	Poor (4)
the ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information. (1)				

Q27 **Comments**

____

Q28 **Basic Academic Technology Literacy Skills**

This section of the modified Delphi method study survey will ask you to pair basic academic technology literacy skills in basic computers, word processing, spreadsheet, Database, presentation, and email/communication skills with the appropriate Dreyfus Skill Acquisition level: novice, advanced beginner, competent, proficient and expert skill levels. Once a question has reached an 80% consensus level, it is removed from the surveys subsequent rounds. Feedback for each round will be provided for confirmation/clarification before the next round.

For each pairing ask yourself - A/An (insert skill level) should be able to do this task.
Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.
Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level.

Q29
Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.
Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level.

Computer Skills

	Novice (1)	Advanced Beginner (2)	Competent (3)	Proficient (4)	Expert (5)
Copy/Delete a file (1)					
Retrieve a deleted file (2)					
Select appropriate software program (3)					
Create a program/app shortcut on Desktop (4)					
Pin a program/app to Task Bar (5)					
Install and configure new Operating System (OS) (6)					
Customize Personal Settings - i.e. screen resolution, change					

background, reorganize desktop icons (7)

Share documents via removable storage devices - i.e. USB keys (8)

Connect/disconnect from a wireless network (9)

Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System (10)

Setup a wireless printer (11)

Create/delete a folder (12)

Connect to Cloud storage (13)

Add/remove programs/apps (14)

Map a network drive (15)

Design and install an office network (16)

Restart a frozen/locked up computer (17)

Enter, change, save BIOS settings (18)

Add hardware - i.e. new hard drive, CD/DVD, media card reader (19)

Format a hard drive (20)

Format removable storage device - i.e. USB drives/keys, SD cards (21)

Partition a hard drive (22)

Q30
Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.
Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level

Word Processing Skills

	Novice (1)	Advanced Beginner (2)	Competent (3)	Proficient (4)	Expert (5)
Create a new document (1)					
Opening an existing document (2)					
Add image to document (3)					
Formatting text (4)					
Copy & Paste (5)					
Set tabs (6)					
Set margins (7)					
Create table (8)					
Add a new source for bibliography and create bibliography (9)					

Add header or footer (10)

Create a Blog post (11)

Insert an Online Video (12)

Insert Page Number and Page Breaks (13)

Generate a Table of Contents (14)

Click to write Statement 21 (15)

Format with Styles (16)

Work in Read Mode View (17)

Find and replace text (18)

Track and review changes (19)

Lock and Unlock Tracking (20)

Change line spacing in a paragraph (21)

Q31
Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.
Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level

Spreadsheet Skills

	Novice (1)	Advanced Beginner (2)	Competent (3)	Proficient (4)	Expert (5)
Create a new document (1)					
Find and open an existing document					
Turn on text wrapping (3)					
Enter data into spreadsheet (4)					
Enter simple formulas such as MAX, SUM, MIN and AVG (5)					
Create charts or graphs (6)					
Sort and Filter data (7)					
Add rows or columns (8)					
Change font and size (9)					
Add cell borders and shading (10)					
Apply conditional formatting (11)					

Change height and width of rows and columns (12)

Freeze column and row titles (13)

Clear or delete cells (14)

Find/replace data

Add a worksheet and rename (16)

Filter and sort table information

Link formulas/functions between worksheets (18)

Change Page Setup options (19)

Understand Formulas and Functions (20)

Error checking and trace error

Format chart objects (22)

Create and use Macros (23)

Create and use Pivot Tables (24)

Upload to cloud

Format data as a table (26)

Use fill handle to copy cells (27)

Use database functions (sort, query, mail merge, etc.. (28)

Q32

Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.

Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level

Database Skills

	Novice (1)	Advanced Beginner (2)	Competent (3)	Proficient (4)	Expert (5)
Create a new database (1)					
Find and open existing document (2)					
Create a new table (3)					
Change table view (4)					
Use database functions (sort, query, mail merge) (5)					
Hide a field (6)					
Create a form (7)					
Change font and size (8)					
Change form views (9)					

Move or delete fields (10)

Import/export data (11)

Add a record to a table and form (12)

Navigate records in a form (13)

Search for a record using a form (14)

Sort and filter records (15)

Apply conditional formatting (16)

Perform a query (17)

Create a report (18)

Enter data into an existing database (19)

Q33
Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.
Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level

Presentation Skills

	Novice (1)	Advanced Beginner (2)	Competent (3)	Proficient (4)	Expert (5)
Create a new presentation					
Delete a slide					
Create a photo album presentation					
Change PowerPoint views (4)					
Insert slides					
Change content in a presentation					
Preview a slide show (7)					
Add and Edit a Slide show					
Apply a theme (9)					
Set line Spacing (10)					

Insert, size and move clip art (11)

Add text boxes (12)

Add a video clip to a slide

Move a slide object (14)

Add sound and video to slides (15)

Animate objects (tables, charts, clip art, etc..) (16)

Reorganize slides (17)

Reuse a slide

Define slide transitions

Record narration (20)

Create speaker notes

Run a slide show (22)

Create a self-running slideshow (23)

Present Online (24)

Copy presentation to USB or Cloud (25)

Q34

Novice: Has no or very little experience with the task they are being asked to perform. Needs continual direction and instruction to complete the task.
Advanced Beginner: Able to complete a simple task without continual direction. Starts to develop background knowledge of task – problem-solving skills.
Competent: Able to accurately complete tasks independently. Able to problem-solve issues related to task with minimal guidance.
Proficient: Able to accurately complete multiple tasks independently. Able to problem-solve issues related to the task. Confidently guides novice and advanced beginners.
Expert: Has considerable experience and a deep understanding of the subject matter, and does not need direction and instructions to complete complex tasks. Able to problem-solve issues related to the task at an advanced level

E-mail Communication Skills

	Novice (1)	Advanced Beginner (2)	Competent (3)	Proficient (4)	Expert (5)
Compose a new e-mail (1)					
Create a new contact (2)					
Import/export contact list (3)					
Include CC and BCC's to an email (4)					
Schedule an appointment (5)					
Invite attendees to an appointment (6)					
Customize the Navigation Bar (7)					

Search for e-mail items or people (8)

Work with a to-do bar (9)

Link contacts (10)

Send a file attachment (11)

Reply to or forward a message (12)

Work with Conversation - part of same thread (13)

Screen Junk mail (14)

Create rules for emails (15)

Mark email with high priority (16)

Link other e-mail accounts to Outlook (17)

Q35 **Comments**

Q36 **Survey Participation Appreciation**

Thank you for your participation in this modified Delphi method study. Once all of the responses have been analyzed and grouped by those meeting the 80% consensus cut-off and those that did not, the results will be presented to you for feedback. As mentioned in the informed consent form, in appreciation for you completing all three rounds, you will be presented an electronic $50.00 Amazon Gift card. Unfortunately, the completion of just one or two of the rounds will not qualify you for the electronic $50.00 Amazon Giftcard.

APPENDIX L

INTEGRATION QUESTIONNAIRE INVITATION EMAIL

Good morning [redacted],

My name is Steve Luft. I am a doctoral candidate in the Adult and Higher Education program. I am reaching out to see if you would participate in a short questionnaire. The integration questionnaire consists of seven open-ended questions looking at how the ATLAS rubric (see attached document) could theoretically be integrated into an academic setting.

If you are interested in moving my research forward by participating, I will follow up with the link to the integration questionnaire. If you have any question about my research and/or the questionnaire, please feel free to contact me.

I would greatly appreciate your participation.

APPENDIX M

INTEGRATION QUESTIONNAIRES

Course

Department

College

University

After reading the purpose and significance of this study and an example of how the ATLAS rubric could be used,

how feasible do you feel it would be to integrate the ATLAS into one of your course?

what policies and procedures would need to be adhered to in order to integrate the ATLAS within one of your course?

what challenges do you foresee with integrating the ATLAS within one of your course?

what advantages do you foresee with integrating the ATLAS within one of your course?

what opportunities do you foresee with integrating the ATLAS within one of your course?

do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within one of your course?

what value would you place on the integration of the ATLAS within one of your course?

Comments

After reading the purpose and significance of this study and an example of how the ATLAS rubric could be used,

how feasible do you feel the integration of the ATLAS within the department as a whole?

what policies and procedures would need to be adhered to in order to integrate the ATLAS within the department as a whole?

what challenges do you foresee with integrating the ATLAS within the department as a whole?

what advantages do you foresee with integrating the ATLAS within the department as a whole?

what opportunities do you foresee with integrating the ATLAS within department as a whole?

do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within the department as a whole?

what value would you place on the integration of the ATLAS within the department as a whole?

Comments

After reading the purpose and significance of this study and an example of how the ATLAS rubric could be used,

how feasible do you feel the integration of the ATLAS within the college as a whole?

what policies and procedures would need to be adhered to in order to integrate the ATLAS within the college as a whole?

what challenges do you foresee with integrating the ATLAS within the college as a whole?

what advantages do you foresee with integrating the ATLAS within the college as a whole?

what opportunities do you foresee with integrating the ATLAS within college as a whole?

do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within the college as a whole?

what value would you place on the integration of the ATLAS within the college as a whole?

Comments

After reading the purpose and significance of this study and an example of how the ATLAS rubric could be used,

how feasible do you feel the integration of the ATLAS within the university as a whole?

what policies and procedures would need to be adhered to in order to integrate the ATLAS within the university as a whole?

what challenges do you foresee with integrating the ATLAS within the university as a whole?

what advantages do you foresee with integrating the ATLAS within the university as a whole?

what opportunities do you foresee with integrating the ATLAS within university as a whole?

do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within the university as a whole?

what value would you place on the integration of the ATLAS within the university as a whole?

Comments

APPENDIX N

INSTITUTIONAL REVIEW BOARD (IRB) APPLICATION

MONTANA STATE UNIVERSITY
Request for Designation of Research as Exempt from the Requirement of Institutional Review Board Review
(12/1/2017)

****

THIS AREA IS FOR INSTITUTIONAL REVIEW BOARD USE ONLY. DO NOT WRITE IN THIS AREA.

Confirmation Date:

Application Number:

****

DATE: __1/16/18______________________

I. INVESTIGATOR(s):

Name: **Steve Luft**

Department/**Complete** Address: 2831 Catron St Unit #1
Bozeman, MT 59718

Telephone: (406) 404-1594

E-Mail Address: sluft28@gmail.com stephen.luft@msu.montana.edu

DATE TRAINING COMPLETED: __1/11/2018_____ *[Required training: CITI training; see website for link]*

Name of Faculty Sponsor (if above is a student; also must complete CITI training):

Dr. Carrie Myers and Dr. Nicholas Lux (CITI 6/27/2017)

SIGNATURE (INVESTIGATOR or ADVISOR): ___

____

(If more than one investigator, repeat information for all investigators or team members.)

II. TITLE OF RESEARCH PROJECT: (Try to keep title on first page.)

Technology Literacy: A Modified Delphi Study to Identify Exemplary Technology Literacy Definitions, Develop a Basic Academic Technology Literacy Rubric (BATLR) and methods of integration.

III. BRIEF DESCRIPTION OF RESEARCH METHODS (also see section VII). If using a survey/questionnaire,
provide a copy with this application.

The purpose of this modified Delphi method study is to identify exemplary technology literacy definitions from current technology literacy definitions, develop a basic academic technology literacy rubric and identify steps needed to implement the rubric system at the program, department, college and university level.

The significance of this study looks at technology literacy definitions and basic academic technology literacy skills with a pragmatic approach. The first part of this study is to gain a better understanding of the current technology literacy definitions. The second part of the study is to develop a basic academic technology literacy skills rubric. This study will also create a mechanism for students, faculty, and anyone associated with basic academic technology literacy skills to assess their current skill level and what is required to move to the next level. This part could also be used by faculty to set specific course outcomes and provide students the framework to successfully meet those outcomes. The third part of this study focuses on the implementation of the basic academic technology literacy skills rubric at the course, program, department, college and university level. The significance of this is that it explores the feasibility of implementing the rubric system from the perspective of the individuals at each of the respective levels.

This study will be conducted in four parts, sequentially; a single heuristic evaluation (survey 1), a pilot study of the modified Delphi method study (survey 2), the modified Delphi method study (survey 3), and an integration questionnaire (survey 4). The four-survey instruments to be used in this study will be administered sequentially. Information from survey one will provide information for survey two, with survey two providing information for survey three, and survey three providing the information for survey four. Survey one will be explained in this application. Survey two, three, and four will be explained with a Request for Minor Modifications once the surveys are created with the information from the subsequent survey. See table – Criteria for Research Design below for survey details.

The Delphi method in all forms, including the classical/traditional, is primarily a “structured communication” typically consisting of three rounds of information gathering to building consensus related to a topic. This type of research method utilizes both qualitative and quantitative methods. The first round typically employs an open-ended questionnaire. The next two rounds are structured and are created from information from each subsequent round, and is typically more quantitative in design. A modified Delphi method study is when one or more aspects of the traditional/classical have been modified such as changes in how rounds are formatted and conducted. A modification can also be how the survey is administered such as by conventional mail versus e-mail.

Criteria for Research Design

	Survey 1: Single Heuristic Evaluation Complete first	**Survey 2: Pilot Study Complete second**	**Survey 3: Modified Delphi Method Study Complete third**	**Survey 4: Integration Questionnaire Complete fourth**
Nature of the Study	Reduce 25 technology literacy definition down to 10 technology literacy definition - Used as part one of modified Delphi method study.	Test modified Delphi method study instrument for validity and reliability.	Identify exemplary technology literacy definitions and create a basic academic technology literacy rubric.	Procedures required for integration of basic academic technology literacy systems into a course, program, department, college, and university.
Participants /Sample	Three to five experts from academic areas within higher education with a strong technology component.	Three participants from the Teaching Excellence Action Committee (TEACh).	Ten to 15 individuals from a cohort of CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office during the spring 2018 semester courses offered at institutions of higher education in the state of Montana.	Five - An individual will be selected from each of the five academic areas: course, program, department, college, and university for a total of five participants. Although not considered

			an administrator, one faculty member from the course level will be invited to participate.

The table below outlines the research questions, goals of the study, data collection instrument and outcomes.

Research questions, study goals, Data Collection, and Outcomes.

Research Questions	**Goal/Objective**	**Data Collection/Instrument**	**Outcome**
RQ1: How do technology experts in higher education define technology literacy?	Bring forward a list of 10 exemplary technology literacy definitions reduced by technology experts from 26 technology literacy definitions identified in the literature.	Heuristic Evaluation reducing 25 technology literacy definitions to 10. These 10 definitions will be included as part of the modified Delphi method study.	Exemplary technology literacy definitions
RQ2: How do technology experts in higher education pair basic academic technology literacy skills with skill levels to create a basic academic technology literacy?	Develop a basic academic technology literacy rubric.	Modified Delphi Method Study	A basic academic technology literacy rubric.
RQ3: What steps would need to be taken to	Identify the steps required to integrate the basic academic	Integration Questionnaire	Procedures identified to integrate the

integrate the basic academic technology literacy rubric at the course, program, department, college and university level?	technology literacy rubric at the course, program, department, college and university level.	basic academic technology literacy rubric at the course, program, department, college and university level.

The population the heuristic evaluation, pilot study, modified Delphi method study and integration questionnaire sample will be selected from current and retired employees of the Montana University System (MUS). The sample for survey one (heuristic evaluation) will consist of a panel of 3-5 experts from current and recently retired employees of the Montana University System (MUS) selected using a snowball selection method. The first participant selected is a MUS colleague with a vast and diverse technology background. This participant will be asked to provide the information for the subsequent participants. The criteria for selection of the panel is knowledge of higher education academics, technology integration into higher education classrooms, and how students use integrated technology in the classrooms.

There are no anticipated risks associated with the participation in this study. While there are no direct benefits to the panel for participation, indirectly they will help advance this study by providing an expert evaluation and selection of exemplary technology literacy definitions.

A letter of consent will be emailed to all the selected participants briefing them as to the nature of this study, and particularly the section involving them. Included in this letter is a notification that they will not be compensated for their participation in survey one. Participants of survey two and four will also not be compensated for their participation. Participants of survey three will be compensated for their time with an Amazon gift card. The amount is to be determined during the development of the survey three instrument.

The survey one instrument (copy provided with this application) will be administered using Qualtrics. A link to the survey will be emailed to the participants individually to prevent an accidental revealing of participants to other participants. Survey one will remain active for seven days and will only be administered once. The responses to the single heuristic evaluation will remain confidential for the duration of this study, and will only be known by the researcher. Responses for all four of the surveys will be stored securely on the Qualtrics server and researcher's personal computer, both of which are password protected with the password known only by the researcher. Data for all four surveys will be deleted from the Qualtrics server at the completion of the dissertation, and after five years on the researcher's personal computer.

Once survey one is complete, the results will be sent back to the participates for review and comments. The final results of survey one will be used as the first part of the pilot study/modified Delphi method instrument, which are survey instruments two and three. At the completion of each survey, the data will be distributed back to the participants for authentication and feedback. The results of all four surveys will be compiled and disseminated in the final dissertation, presented during the dissertation defense, and publicized to a larger audience in possible publications.

IV. RISKS AND INCONVENIENCES TO SUBJECTS (also see section VII; **do not answer 'None'**):

There are no anticipated risks and/or inconveniences associated with the participation in this study.

V. SUBJECTS:

A. Expected numbers of subjects: **See table below**

Sample, Sampling Method and Sample Number

Data Collection Method	Sampling Method	Sample Number	Sample Cohort
Survey One: Heuristic Evaluation	Snowball	3 to 5	from within higher education in the state of Montana with a strong technology knowledgebase
Survey Two: Pilot Study	Convenience	3 to 5	from the Teaching Excellence Action Committee (TEACh) located on the Montana State University campus
Survey Three: Modified Delphi Method Study	Purposive	10 to 15	cohort of instructors teaching CAPP 120 - Introduction to Computers and CAPP 131 – Microsoft Office during the spring 2018 semester

Survey Four: Integration Questionnaire	Purposive	5	an individual will be selected from each of the five academic areas: course, department, college and university

B. Will research involve minors (age <18 years)? Yes **No**
(If 'Yes', please specify and justify.)

C. Will research involve prisoners? Yes **No**

D. Will research involve any specific ethnic, racial, religious, etc. groups of people?
(If 'Yes', please specify and justify.) Yes **No**

E. Will a consent form be used? **Yes** No (Please use accepted format from our website. Be sure to indicate that participation is voluntary. Provide a stand-alone copy. Do not include the form here.)

F.

VI. FOR RESEARCH INVOLVING SURVEYS OR QUESTIONNAIRES:
(Be sure to indicate on each instrument, survey or questionnaire that participation is voluntary.)

A. Is information being collected about:
Sexual behavior? Yes **No**
Criminal behavior? Yes **No**
Alcohol or substance abuse? Yes **No**
Matters affecting employment? Yes **No**
Matters relating to civil litigation? Yes **No**

B. Will the information obtained be completely anonymous, with no identifying information linked to the responding subjects? Yes **No**

C. If identifying information will be linked to the responding subjects, how will the subjects be identified? (Please circle or bold your answers)
By name Yes **No**
By code Yes **No**
By other identifying information **Yes** No

D. Does this survey utilize a standardized and/or validated survey tool/questionnaire? **Yes** No

VII. FOR RESEARCH BEING CONDUCTED IN A CLASSROOM SETTING: **Not Applicable**

A. Will research involve blood draws? Yes No
(If Yes, please follow protocol listed in the "Guidelines for Describing Risks: blood, etc.", section I-VI.)

VIII. FOR RESEARCH INVOLVING PATIENT INFORMATION, MATERIALS, BLOOD OR TISSUE
SPECIMENS RECEIVED FROM OTHER INSTITUTIONS: **Not Applicable**

A. Are these materials linked in any way to the patient (code, identifier, or other link to
patient identity)? Yes **No**

B. Are you involved in the design of the study for which the materials are being collected?
Yes No

C. Will your name appear on publications resulting from this research?
Yes No

D. Where are the subjects from whom this material is being collected?

E. Has an IRB at the institution releasing this material reviewed the proposed project?
(If 'Yes", please provide documentation.) Yes No

F. Regarding the above materials or data, will you be:

Collecting them	Yes	No
Receiving them	Yes	No
Sending them	Yes	No

G. Do the materials already exist? Yes No

H. Are the materials being collected for the purpose of this study? Yes No

I. Do the materials come from subjects who are:

Minors	Yes	No
Prisoners	Yes	No
Pregnant women	Yes	No

J. Does this material originate from a patient population that, for religious or other reasons,
would prohibit its use in biomedical research?
Yes No Unknown source

IX. FOR RESEARCH INVOLVING MEDICAL AND/OR INSURANCE RECORDS

A. Does this research involve the use of:
Medical, psychiatric and/or psychological records Yes No
Health insurance records Yes No
Any other records containing information regarding personal health and illness
Yes No

If you answered "Yes" to any of the items in this section, you must complete the HIPAA Worksheet.

APPENDIX O

SINGLE HEURISTIC EVALUATION – RESPONSES

Ten Technology Literacy Definitions identified by Single Heuristic Evaluation

Score	Question # in HE report	Ten Technology Literacy Definitions identified by Heuristic Evaluation – in order of score - highest first
8	Q21	Dugger Jr, W. E. (2001). Standards for technological literacy. *Phi Delta Kappan, 82*(7), 513. is the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.
6	Q17	US Department of Education [DOE]. (1996). *Getting America's students ready for the 21st century: meeting the technology literacy challenge: a report to the Nation on Technology and Education*. Computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic.
6	Q19	Hansen, J. W. (2003). *To change perceptions of technology programs.* Paper presented at the The Journal of Technology Studies. an individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment.
6	Q20	State Educational Technology Directors Association [SETDA]. (2007). *2007 Technology Literacy Assessment and Educational Technology Standards Report*. Retrieved from http://www.setda.org/wp-content/uploads/2015/03/TEchnologyLiteracy2007Final.pdf New York Technology literacy is: An understanding of the concepts behind computing equipment, network connectivity, and application software;

		The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and The ability to acquire new knowledge for on-going and lifelong learning in the 21st century.
5	Q18	Colorado Department of Education. (2009). Technology Literacy Assessment Project. Retrieved from http://www.coloradotechliteracy.org/org/documentation/pdfs/module1pdfs/TLAPMod-1.pdf the ability to responsibly use appropriate technology to: Communicate Solve problems Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas Acquire lifelong knowledge and skills in the 21st century
5	Q23	State Educational Technology Directors Association [SETDA]. (2007). *2007 Technology Literacy Assessment and Educational Technology Standards Report*. Retrieved from http://www.setda.org/wp-content/uploads/2015/03/TEchnologyLiteracy2007Final.pdf Alaska Technology literacy and proficiency is the ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills.
4	Q22	Selfe, C. L. (1999). *Technology and literacy in the 21st century: The importance of paying attention*: SIU Press. a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.
4	Q24	Leu, D. J., & Kinzer, C. K. (2000). The convergence of literacy instruction with networked technologies for information and communication. *Reading Research Quarterly*, *35*(1), 108-127. the ability to gather, organize, analyze, and report information using technology.

4	Q25	International Society for Technology in Education [ISTE]. (2007a). NETS for Students Profiles for Technology Literate Students. Retrieved from https://www.iste.org/docs/pdfs/nets-s-2007-student-profiles-en.pdf?sfvrsn=4 the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.
4	Q26	State Educational Technology Directors Association [SETDA]. (2007). *2007 Technology Literacy Assessment and Educational Technology Standards Report*. Retrieved from http://www.setda.org/wp-content/uploads/2015/03/TEchnologyLiteracy2007Final.pdf Georgia the ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.

APPENDIX P

PILOT STUDY – RAW DATA

Technology Literacy Definition – Pilot Study

Question #	Technology Literacy Definition	Excellent		Good		Fair		Poor		N=
Q17	computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic.	25.00%	1	50.00%	2	25.00%	1	0.00%	0	4
Q18	the ability to responsibly use appropriate technology to: • Communicate • Solve problems • Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas • Acquire lifelong knowledge and skills in the 21st century	0.00%	0	75.00%	3	25.00%	1	0.00%	0	4
Q19	an individual’s abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment.	25.00%	1	25.00%	1	50.00%	2	0.00%	0	4
Q20	• An understanding of the concepts behind computing equipment, network connectivity, and application software; • The skills to responsibly use appropriate technology to access, synthesize, evaluate,	0.00%	0	75.00%	3	25.00%	1	0.00%	0	4

	communicate, and create information to solve problems and improve learning in all subject areas; and									
	The ability to acquire new knowledge for on-going and lifelong learning in the 21st century global workplace.									
Q21	the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.	25.00%	1	25.00%	1	50.00%	2	0.00%	0	4
Q22	a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.	0.00%	0	50.00%	2	25.00%	1	25.00%	1	4
Q23	and proficiency is the ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills.	25.00%	1	25.00%	1	50.00%	2	0.00%	0	4
Q24	the ability to gather, organize, analyze, and report information using technology.	25.00%	1	0.00%	0	50.00%	2	25.00%	1	4
Q25	the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and	25.00%	1	50.00%	2	25.00%	1	0.00%	0	4

	create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.									
Q26	the ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.	25.00%	1	25.00%	1	50.00%	2	0.00%	0	4

Computer Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N=
1	Copy/delete a file	0.00%	0	25.00%	1	0.00%	0	25.00%	1	50.00%	2	4
2	Retrieve a deleted file	25.00%	1	0.00%	0	0.00%	0	25.00%	1	50.00%	2	4
3	Select appropriate software program	25.00%	1	0.00%	0	0.00%	0	25.00%	1	50.00%	2	4
4	Creating a program/app shortcut on Desktop	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
5	Pinning programs/apps to Task Bar	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
6	Install and configure new Operating System (OS)	25.00%	1	25.00%	1	0.00%	0	50.00%	2	0.00%	0	4
7	Customize Personal Settings - i.e. screen resolution, change background, reorganize icons	0.00%	0	25.00%	1	25.00%	1	25.00%	1	25.00%	1	4
8	Share Document- via removable storage devices	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
9	Connect or disconnect from a wireless network	0.00%	0	25.00%	1	0.00%	0	50.00%	2	25.00%	1	4
10	Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System	0.00%	0	0.00%	0	0.00%	0	50.00%	2	50.00%	2	4
11	Setup a wireless printer	0.00%	0	0.00%	0	25.00%	1	75.00%	3	0.00%	0	4
12	Create/delete folder	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
13	Connecting to Cloud storage	0.00%	0	0.00%	0	25.00%	1	50.00%	2	25.00%	1	4

14	Add or remove programs/apps	0.00%	0	25.00%	1	0.00%	0	25.00%	1	50.00%	2	4
15	Map a network drive	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
16	Design and install an office network	50.00%	2	25.00%	1	0.00%	0	0.00%	0	25.00%	1	4
17	Restart a frozen computer	0.00%	0	25.00%	1	0.00%	0	25.00%	1	50.00%	2	4
18	Enter, change and save BIOS setting	25.00%	1	0.00%	0	25.00%	1	50.00%	2	0.00%	0	4
19	Add hardware - i.e. new hard drive, CD/DVD, Media card reader	25.00%	1	0.00%	0	0.00%	0	50.00%	2	25.00%	1	4
20	Format hard drive	0.00%	0	0.00%	0	50.00%	2	25.00%	1	25.00%	1	4
21	Format removable storage devices - i.e. USB drives/keys, SD cards	0.00%	0	0.00%	0	50.00%	2	50.00%	2	0.00%	0	4
22	Partition a hard drive	0.00%	0	0.00%	0	50.00%	2	0.00%	0	50.00%	2	4

Word-Processing Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N=
1	Create a new document	25.00%	1	0.00%	0	0.00%	0	0.00%	0	75.00%	3	4
2	Opening an existing document	25.00%	1	0.00%	0	0.00%	0	0.00%	0	75.00%	3	4
3	Add image to document	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
4	Formatting text	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
5	Copy & Paste	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4

6	Set tabs	0.00%	0	0.00%	0	50.00%	2	0.00%	0	50.00%	2	4
7	Set margins	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
8	Create table	0.00%	0	0.00%	0	25.00%	1	50.00%	2	25.00%	1	4
9	Add a new source for bibliography and create bibliography	0.00%	0	0.00%	0	50.00%	2	25.00%	1	25.00%	1	4
10	Add header or footer	0.00%	0	0.00%	0	25.00%	1	50.00%	2	25.00%	1	4
11	Create a Blog post	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
12	Insert an Online Video	0.00%	0	25.00%	1	0.00%	0	25.00%	1	50.00%	2	4
13	Insert Page Number and Page Breaks	0.00%	0	0.00%	0	50.00%	2	0.00%	0	50.00%	2	4
14	Generate a Table of Contents	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
15	Generate a Table of Tables and Table of Figures	0.00%	0	50.00%	2	0.00%	0	25.00%	1	25.00%	1	4
16	Format with Styles	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
17	Work in Read Mode View	0.00%	0	0.00%	0	0.00%	0	75.00%	3	25.00%	1	4
18	Find and replace text	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
19	Track and review changes	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
20	Lock and Unlock Tracking	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
21	Change line spacing in a paragraph	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4

Spreadsheet Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N=
1	Create a new document	25.00%	1	25.00%	1	0.00%	0	0.00%	0	50.00%	2	4
2	Find and open an existing document	25.00%	1	0.00%	0	0.00%	0	25.00%	1	50.00%	2	4
3	Turn on text wrapping	25.00%	1	0.00%	0	0.00%	0	25.00%	1	50.00%	2	4
4	Enter data into spreadsheet	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
5	Enter simple formulas such as MAX, SUM, MIN and AVG	0.00%	0	25.00%	1	25.00%	1	25.00%	1	25.00%	1	4
6	Create charts or graphs	25.00%	1	0.00%	0	25.00%	1	25.00%	1	25.00%	1	4
7	Sort and Filter data	0.00%	0	0.00%	0	50.00%	2	25.00%	1	25.00%	1	4
8	Add/delete rows or columns	0.00%	0	50.00%	2	0.00%	0	25.00%	1	25.00%	1	4
9	Change font and size	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
10	Add cell borders and shading	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
11	Apply conditional formatting	25.00%	1	0.00%	0	25.00%	1	50.00%	2	0.00%	0	4
12	Change height and width of rows and columns	0.00%	0	0.00%	0	50.00%	2	0.00%	0	50.00%	2	4
13	Freeze column and row titles	25.00%	1	0.00%	0	25.00%	1	0.00%	0	50.00%	2	4
14	Clear or delete cells	0.00%	0	50.00%	2	0.00%	0	0.00%	0	50.00%	2	4
15	Find and replace data	0.00%	0	50.00%	2	0.00%	0	0.00%	0	50.00%	2	4
16	Add a worksheet and rename	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
17	Filter and sort table information	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4

18	Link formulas/functions between worksheets	25.00%	1	0.00%	0	0.00%	0	25.00%	1	50.00%	2	4
19	Change Page Setup options	25.00%	1	0.00%	0	25.00%	1	25.00%	1	25.00%	1	4
20	Understand Formulas and Functions	0.00%	0	25.00%	1	25.00%	1	50.00%	2	0.00%	0	4
21	Error checking and trace error	50.00%	2	0.00%	0	25.00%	1	25.00%	1	0.00%	0	4
22	Format chart objects	25.00%	1	25.00%	1	25.00%	1	25.00%	1	0.00%	0	4
23	Create and use Macros	50.00%	2	25.00%	1	0.00%	0	0.00%	0	25.00%	1	4
24	Create and use Pivot Tables	50.00%	2	0.00%	0	0.00%	0	25.00%	1	25.00%	1	4
25	Upload to cloud	25.00%	1	0.00%	0	25.00%	1	0.00%	0	50.00%	2	4
26	Format data as a table	25.00%	1	25.00%	1	25.00%	1	0.00%	0	25.00%	1	4
27	Use fill handle to copy cells	25.00%	1	0.00%	0	50.00%	2	0.00%	0	25.00%	1	4
28	Use database functions (sort, query, mail merge, etc..	50.00%	2	0.00%	0	25.00%	1	25.00%	1	0.00%	0	4

Database Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N=
1	Create a new database	50.00%	2	25.00%	1	0.00%	0	0.00%	0	25.00%	1	4
2	Find and open existing document	50.00%	2	25.00%	1	0.00%	0	0.00%	0	25.00%	1	4
3	Create a new table	75.00%	3	0.00%	0	25.00%	1	0.00%	0	0.00%	0	4
4	Change table view	50.00%	2	25.00%	1	25.00%	1	0.00%	0	0.00%	0	4
5	Use database functions (sort, query, mail merge)	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
6	Hide a field	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
7	Create a form	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
8	Change font and size	50.00%	2	25.00%	1	0.00%	0	0.00%	0	25.00%	1	4
9	Change form views	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
10	Move or delete fields	50.00%	2	25.00%	1	25.00%	1	0.00%	0	0.00%	0	4
11	Import/export data	50.00%	2	0.00%	0	25.00%	1	25.00%	1	0.00%	0	4
12	Add a record to a table and form	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
13	Navigate records in a form	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
14	Search for a record using a form	50.00%	2	0.00%	0	50.00%	2	0.00%	0	0.00%	0	4
15	Sort and filter records	50.00%	2	0.00%	0	25.00%	1	25.00%	1	0.00%	0	4
16	Apply conditional formatting	50.00%	2	25.00%	1	0.00%	0	25.00%	1	0.00%	0	4
17	Perform a query	50.00%	2	25.00%	1	25.00%	1	0.00%	0	0.00%	0	4
18	Create a report	50.00%	2	25.00%	1	25.00%	1	0.00%	0	0.00%	0	4
19	Enter data into an existing database	25.00%	1	25.00%	1	25.00%	1	25.00%	1	0.00%	0	4

Presentation Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N=
1	Create a new presentation	25.00%	1	0.00%	0	0.00%	0	0.00%	0	75.00%	3	4
2	Delete a slide	25.00%	1	0.00%	0	0.00%	0	0.00%	0	75.00%	3	4
3	Create a photo album presentation	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
4	Change PowerPoint views	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
5	Insert slides	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
6	Change content in a presentation	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
7	Preview a slide show	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
8	Add and Edit a Slide show	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
9	Apply a theme	25.00%	1	25.00%	1	0.00%	0	0.00%	0	50.00%	2	4
10	Set line Spacing	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
11	Insert, size and move clip art	0.00%	0	0.00%	0	0.00%	0	50.00%	2	50.00%	2	4
12	Add text boxes	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
13	Add a video clip to a slide	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
14	Move a slide object	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
15	Add sound and video to slides	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
16	Animate objects (tables, charts, clip art, etc..)	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4

17	Reorganize slides	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
18	Change font and size	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
19	Reuse a slide	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
20	Define slide transitions	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
21	Record narration	0.00%	0	25.00%	1	25.00%	1	25.00%	1	25.00%	1	4
22	Create speaker notes	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
23	Run a slide show	0.00%	0	25.00%	1	0.00%	0	25.00%	1	50.00%	2	4
24	Create a self-running slideshow	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
25	Present Online	0.00%	0	25.00%	1	0.00%	0	25.00%	1	50.00%	2	4
26	Copy presentation to USB or Cloud	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4

E-mail Communication Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N=
1	Compose a new e-mail	25.00%	1	0.00%	0	0.00%	0	0.00%	0	75.00%	3	4
2	Create a new contact	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
3	Import/Export contact list	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
4	Include CC and BCC's to email	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
5	Schedule an appointment	0.00%	0	0.00%	0	25.00%	1	25.00%	1	50.00%	2	4
6	Invite attendees to an appointment	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
7	Customize the Navigation Bar	0.00%	0	0.00%	0	25.00%	1	50.00%	2	25.00%	1	4
8	Search for e-mail items or people	0.00%	0	0.00%	0	25.00%	1	0.00%	0	75.00%	3	4
9	Work with a to-do bar	0.00%	0	25.00%	1	25.00%	1	50.00%	2	0.00%	0	4
10	Link contacts	25.00%	1	0.00%	0	50.00%	2	25.00%	1	0.00%	0	4
11	Send a file attachment	0.00%	0	25.00%	1	0.00%	0	0.00%	0	75.00%	3	4
12	Reply/forward a message	25.00%	1	0.00%	0	0.00%	0	0.00%	0	75.00%	3	4
13	Work with Conversations - part of same thread	0.00%	0	25.00%	1	25.00%	1	0.00%	0	50.00%	2	4
14	Screen Junk mail	0.00%	0	0.00%	0	50.00%	2	25.00%	1	25.00%	1	4
15	Create rules for emails	0.00%	0	25.00%	1	25.00%	1	25.00%	1	25.00%	1	4
16	Mark email with high priority	0.00%	0	0.00%	0	25.00%	1	50.00%	2	25.00%	1	4
17	Link other e-mail accounts to Outlook	0.00%	0	25.00%	1	25.00%	1	25.00%	1	25.00%	1	4

APPENDIX Q

MODIFIED DELPHI METHOD STUDY – ROUND ONE RAW DATA

Modified Delphi method Study - Round One

Technology Literacy Definition

#	Technology Literacy Definition	Excellent		Good		Fair		Poor		N=
Q17	computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic.	20.00%	2	60.00%	6	20.00%	2	0.00%	0	10
Q18	the ability to responsibly use appropriate technology to: • Communicate • Solve problems • Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas • Acquire lifelong knowledge and skills in the 21st century	50.00%	5	30.00%	3	10.00%	1	10.00%	1	10
Q19	an individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment.	20.00%	2	40.00%	4	40.00%	4	0.00%	0	10
Q20	• An understanding of the concepts behind computing equipment, network	20.00%	2	50.00%	5	30.00%	3	0.00%	0	10

	connectivity, and application software; • The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and • The ability to acquire new knowledge for on-going and lifelong learning in the 21st									
Q21	the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.	20.00%	2	40.00%	4	30.00%	3	10.00%	1	10
Q22	a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.	10.00%	1	20.00%	2	30.00%	3	40.00%	4	10
Q23	technology literacy and proficiency is the ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills.	10.00%	1	50.00%	5	30.00%	3	10.00%	1	10
Q24	the ability to gather, organize, analyze, and report information using technology.	20.00%	2	20.00%	2	20.00%	2	40.00%	4	10

Q25	the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
Q26	the ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.	50.00%	5	20.00%	2	20.00%	2	10.00%	1	10

Computer Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		Total
1	Copy/Delete a file	50.00%	5	40.00%	4	10.00%	1	0.00%	0	0.00%	0	10
2	Retrieve a deleted file	10.00%	1	40.00%	4	30.00%	3	10.00%	1	10.00%	1	10
3	Select appropriate software program	30.00%	3	50.00%	5	10.00%	1	10.00%	1	0.00%	0	10
4	Create a program/app shortcut on Desktop	0.00%	0	60.00%	6	40.00%	4	0.00%	0	0.00%	0	10
5	Pin a program/app to Task Bar	0.00%	0	70.00%	7	20.00%	2	10.00%	1	0.00%	0	10
6	Install and configure new Operating System (OS)	0.00%	0	0.00%	0	0.00%	0	**80.00%**	8	20.00%	2	10
7	Customize Personal Settings - i.e. screen resolution, change background, reorganize desktop icons	10.00%	1	40.00%	4	30.00%	3	10.00%	1	10.00%	1	10
8	Share documents via removable storage devices - i.e. USB keys	20.00%	2	60.00%	6	20.00%	2	0.00%	0	0.00%	0	10
9	Connect/disconnect from a wireless network	0.00%	0	60.00%	6	30.00%	3	10.00%	1	0.00%	0	10
10	Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System	0.00%	0	50.00%	5	20.00%	2	10.00%	1	20.00%	2	10
11	Setup a wireless printer	0.00%	0	10.00%	1	70.00%	7	20.00%	2	0.00%	0	10
12	Create/delete a folder	60.00%	6	40.00%	4	0.00%	0	0.00%	0	0.00%	0	10

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13	Connect to Cloud storage	10.00%	1	70.00%	7	20.00%	2	0.00%	0	0.00%	0	10
14	Add/remove programs/apps	0.00%	0	22.22%	2	77.78%	7	0.00%	0	0.00%	0	9
15	Map a network drive	0.00%	0	10.00%	1	40.00%	4	30.00%	3	20.00%	2	10
16	Design and install an office network	0.00%	0	0.00%	0	10.00%	1	30.00%	3	60.00%	6	10
17	Restart a frozen/locked up computer	0.00%	0	40.00%	4	50.00%	5	10.00%	1	0.00%	0	10
18	Enter, change, save BIOS settings	0.00%	0	0.00%	0	20.00%	2	30.00%	3	50.00%	5	10
19	Add hardware - i.e. new hard drive, CD/DVD, media card reader	0.00%	0	10.00%	1	10.00%	1	50.00%	5	30.00%	3	10
20	Format a hard drive	0.00%	0	0.00%	0	50.00%	5	30.00%	3	20.00%	2	10
21	Format removable storage device - i.e. USB drives/keys, SD cards	0.00%	0	40.00%	4	10.00%	1	40.00%	4	10.00%	1	10
22	Partition a hard drive	0.00%	0	0.00%	0	10.00%	1	10.00%	1	**80.00%**	8	10

Word Processing Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		Total
1	Create a new document	**90.00%**	9	10.00%	1	0.00%	0	0.00%	0	0.00%	0	10
2	Opening an existing document	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
3	Add image to document	10.00%	1	**80.00%**	8	10.00%	1	0.00%	0	0.00%	0	10
4	Formatting text	40.00%	4	50.00%	5	10.00%	1	0.00%	0	0.00%	0	10
5	Copy & Paste	60.00%	6	40.00%	4	0.00%	0	0.00%	0	0.00%	0	10
6	Set tabs	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
7	Set margins	30.00%	3	40.00%	4	30.00%	3	0.00%	0	0.00%	0	10
8	Create table	0.00%	0	60.00%	6	40.00%	4	0.00%	0	0.00%	0	10
9	Add a new source for bibliography and create bibliography	0.00%	0	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
10	Add header or footer	0.00%	0	70.00%	7	30.00%	3	0.00%	0	0.00%	0	10
11	Create a Blog post	0.00%	0	0.00%	0	50.00%	5	50.00%	5	0.00%	0	10
12	Insert an Online Video	0.00%	0	30.00%	3	30.00%	3	40.00%	4	0.00%	0	10
13	Insert Page Number and Page Breaks	0.00%	0	60.00%	6	40.00%	4	0.00%	0	0.00%	0	10
14	Generate a Table of Contents	0.00%	0	30.00%	3	30.00%	3	40.00%	4	0.00%	0	10
15	Click to write Statement 21	22.22%	2	0.00%	0	44.44%	4	22.22%	2	11.11%	1	9

16	Format with Styles	10.00%	1	20.00%	2	60.00%	6	10.00%	1	0.00%	0	10
17	Work in Read Mode View	20.00%	2	40.00%	4	20.00%	2	20.00%	2	0.00%	0	10
18	Find and replace text	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
19	Track and review changes	0.00%	0	20.00%	2	50.00%	5	20.00%	2	10.00%	1	10
20	Lock and Unlock Tracking	0.00%	0	30.00%	3	40.00%	4	20.00%	2	10.00%	1	10
21	Change line spacing in a paragraph	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10

Spreadsheet Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		Total
1	Create a new document	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
2	Find and open an existing document	70.00%	7	30.00%	3	0.00%	0	0.00%	0	0.00%	0	10
3	Turn on text wrapping	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
4	Enter data into spreadsheet	60.00%	6	40.00%	4	0.00%	0	0.00%	0	0.00%	0	10
5	Enter simple formulas such as MAX, SUM, MIN and AVG	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
6	Create charts or graphs	0.00%	0	30.00%	3	70.00%	7	0.00%	0	0.00%	0	10
7	Sort and Filter data	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
8	Add rows or columns	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
9	Change font and size	50.00%	5	40.00%	4	10.00%	1	0.00%	0	0.00%	0	10

10	Add cell borders and shading	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
11	Apply conditional formatting	0.00%	0	10.00%	1	60.00%	6	30.00%	3	0.00%	0	10
12	Change height and width of rows and columns	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
13	Freeze column and row titles	0.00%	0	40.00%	4	50.00%	5	10.00%	1	0.00%	0	10
14	Clear or delete cells	40.00%	4	50.00%	5	10.00%	1	0.00%	0	0.00%	0	10
15	Find/replace data	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
16	Add a worksheet and rename	30.00%	3	40.00%	4	30.00%	3	0.00%	0	0.00%	0	10
17	Filter and sort table information	0.00%	0	40.00%	4	20.00%	2	40.00%	4	0.00%	0	10
18	Link formulas/functions between worksheets	0.00%	0	10.00%	1	40.00%	4	50.00%	5	0.00%	0	10
19	Change Page Setup options	30.00%	3	30.00%	3	40.00%	4	0.00%	0	0.00%	0	10
20	Understand Formulas and Functions	0.00%	0	30.00%	3	50.00%	5	10.00%	1	10.00%	1	10
21	Error checking and trace error	0.00%	0	0.00%	0	40.00%	4	50.00%	5	10.00%	1	10
22	Format chart objects	0.00%	0	20.00%	2	60.00%	6	20.00%	2	0.00%	0	10
23	Create and use Macros	0.00%	0	0.00%	0	10.00%	1	50.00%	5	40.00%	4	10
24	Create and use Pivot Tables	0.00%	0	0.00%	0	0.00%	0	50.00%	5	50.00%	5	10
25	Upload to cloud	0.00%	0	40.00%	4	60.00%	6	0.00%	0	0.00%	0	10
26	Format data as a table	0.00%	0	40.00%	4	60.00%	6	0.00%	0	0.00%	0	10
27	Use fill handle to copy cells	20.00%	2	70.00%	7	10.00%	1	0.00%	0	0.00%	0	10

28	Use database functions (sort, query, mail merge, etc..	0.00%	0	10.00%	1	30.00%	3	40.00%	4	20.00%	2	10

Database Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		Total
1	Create a new database	70.00%	7	20.00%	2	10.00%	1	0.00%	0	0.00%	0	10
2	Find and open existing document	60.00%	6	40.00%	4	0.00%	0	0.00%	0	0.00%	0	10
3	Create a new table	20.00%	2	70.00%	7	10.00%	1	0.00%	0	0.00%	0	10
4	Change table view	20.00%	2	**80.00%**	8	0.00%	0	0.00%	0	0.00%	0	10
5	Use database functions (sort, query, mail merge)	0.00%	0	50.00%	5	20.00%	2	30.00%	3	0.00%	0	10
6	Hide a field	0.00%	0	70.00%	7	20.00%	2	10.00%	1	0.00%	0	10
7	Create a form	0.00%	0	50.00%	5	40.00%	4	10.00%	1	0.00%	0	10
8	Change font and size	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
9	Change form views	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
10	Move or delete fields	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
11	Import/export data	0.00%	0	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
12	Add a record to a table and form	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
13	Navigate records in a form	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
14	Search for a record using a form	20.00%	2	30.00%	3	20.00%	2	30.00%	3	0.00%	0	10

15	Sort and filter records	10.00%	1	50.00%	5	20.00%	2	20.00%	2	0.00%	0	10
16	Apply conditional formatting	0.00%	0	10.00%	1	50.00%	5	30.00%	3	10.00%	1	10
17	Perform a query	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
18	Create a report	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
19	Enter data into an existing database	50.00%	5	40.00%	4	10.00%	1	0.00%	0	0.00%	0	10

Presentation Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		Total
1	Create a new presentation	**90.00%**	9	10.00%	1	0.00%	0	0.00%	0	0.00%	0	10
2	Delete a slide	70.00%	7	30.00%	3	0.00%	0	0.00%	0	0.00%	0	10
3	Create a photo album presentation	0.00%	0	60.00%	6	30.00%	3	10.00%	1	0.00%	0	10
4	Change PowerPoint views	10.00%	1	**80.00%**	8	10.00%	1	0.00%	0	0.00%	0	10
5	Insert slides	60.00%	6	40.00%	4	0.00%	0	0.00%	0	0.00%	0	10
6	Change content in a presentation	60.00%	6	30.00%	3	10.00%	1	0.00%	0	0.00%	0	10
7	Preview a slide show	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
8	Add and Edit a Slide show	30.00%	3	40.00%	4	30.00%	3	0.00%	0	0.00%	0	10
9	Apply a theme	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
10	Set line Spacing	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
11	Insert, size and move clip art	20.00%	2	50.00%	5	20.00%	2	10.00%	1	0.00%	0	10
12	Add text boxes	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
13	Add a video clip to a slide	0.00%	0	50.00%	5	20.00%	2	30.00%	3	0.00%	0	10
14	Move a slide object	30.00%	3	40.00%	4	20.00%	2	10.00%	1	0.00%	0	10
15	Add sound and video to slides	0.00%	0	40.00%	4	30.00%	3	30.00%	3	0.00%	0	10
16	Animate objects (tables, charts, clip art, etc..)	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10

17	Reorganize slides	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
18	Reuse a slide	20.00%	2	60.00%	6	10.00%	1	10.00%	1	0.00%	0	10
19	Define slide transitions	0.00%	0	50.00%	5	30.00%	3	20.00%	2	0.00%	0	10
20	Record narration	0.00%	0	10.00%	1	30.00%	3	50.00%	5	10.00%	1	10
21	Create speaker notes	10.00%	1	20.00%	2	60.00%	6	10.00%	1	0.00%	0	10
22	Run a slide show	40.00%	4	60.00%	6	0.00%	0	0.00%	0	0.00%	0	10
23	Create a self-running slideshow	0.00%	0	40.00%	4	50.00%	5	0.00%	0	10.00%	1	10
24	Present Online	10.00%	1	20.00%	2	20.00%	2	40.00%	4	10.00%	1	10
25	Copy presentation to USB or Cloud	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10

E-mail Comm Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		Total
1	Compose a new e-mail	**100.00%**	10	0.00%	0	0.00%	0	0.00%	0	0.00%	0	10
2	Create a new contact	30.00%	3	70.00%	7	0.00%	0	0.00%	0	0.00%	0	10
3	Import/export contact list	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
4	Include CC and BCC's to an email	30.00%	3	60.00%	6	10.00%	1	0.00%	0	0.00%	0	10
5	Schedule an appointment	10.00%	1	70.00%	7	10.00%	1	10.00%	1	0.00%	0	10
6	Invite attendees to an appointment	0.00%	0	60.00%	6	20.00%	2	10.00%	1	10.00%	1	10

7	Customize the Navigation Bar	0.00%	0	20.00%	2	50.00%	5	20.00%	2	10.00%	1	10
8	Search for e-mail items or people	10.00%	1	70.00%	7	20.00%	2	0.00%	0	0.00%	0	10
9	Work with a to-do bar	0.00%	0	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
10	Link contacts	0.00%	0	20.00%	2	70.00%	7	10.00%	1	0.00%	0	10
11	Send a file attachment	30.00%	3	60.00%	6	10.00%	1	0.00%	0	0.00%	0	10
12	Reply to or forward a message	70.00%	7	30.00%	3	0.00%	0	0.00%	0	0.00%	0	10
13	Work with Conversation - part of same thread	0.00%	0	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	10
14	Screen Junk mail	0.00%	0	60.00%	6	20.00%	2	10.00%	1	10.00%	1	10
15	Create rules for emails	0.00%	0	0.00%	0	60.00%	6	20.00%	2	20.00%	2	10
16	Mark email with high priority	10.00%	1	50.00%	5	30.00%	3	10.00%	1	0.00%	0	10
17	Link other e-mail accounts to Outlook	0.00%	0	0.00%	0	40.00%	4	40.00%	4	20.00%	2	10

APPENDIX R

MODIFIED DELPHI METHOD STUDY – ROUND TWO RAW DATA

Modified Delphi Method Study - Round Two

Technology Literacy Definition

#	Technology Literacy Definition	Excellent		Good		Fair		Poor		N=
Q17	computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic.	40.00%	4	30.00%	3	30.00%	3	0.00%	0	10
Q18	the ability to responsibly use appropriate technology to: • Communicate • Solve problems • Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas • Acquire lifelong knowledge and skills in the 21st century	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
Q19	an individual’s abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment.	20.00%	2	70.00%	7	10.00%	1	0.00%	0	10

Q20	• An understanding of the concepts behind computing equipment, network connectivity, and application software; • The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and • The ability to acquire new knowledge for on-going and lifelong learning in the 21st	40.00%	4	20.00%	2	30.00%	3	10.00%	1	10
Q21	the ability of a person to use, manage, assess, and understand technology. A person who is technologically literate understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes and is shaped by society.	10.00%	1	40.00%	4	50.00%	5	0.00%	0	10
Q22	a complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments, including reading, writing, and communicating.	10.00%	1	10.00%	1	60.00%	6	20.00%	2	10
Q23	technology literacy and proficiency is the ability of an individual to use technology effectively,	20.00%	2	70.00%	7	10.00%	1	0.00%	0	10

	appropriately, and responsibly to acquire lifelong knowledge and skills.									
Q24	the ability to gather, organize, analyze, and report information using technology.	10.00%	1	40.00%	4	40.00%	4	10.00%	1	10
Q25	the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
Q26	the ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.	40.00%	4	30.00%	3	20.00%	2	10.00%	1	10

Computer Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Copy/Delete a file	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
2	Retrieve a deleted file	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
3	Select appropriate software program	20.00%	2	70.00%	7	10.00%	1	0.00%	0	0.00%	0	10
4	Create a program/app shortcut on Desktop	10.00%	1	40.00%	4	40.00%	4	10.00%	1	0.00%	0	10
5	Pin a program/app to Task Bar	0.00%	0	60.00%	6	30.00%	3	10.00%	1	0.00%	0	10
6	Customize Personal Settings - i.e. screen resolution, change background, reorganize desktop icons	0.00%	0	50.00%	5	30.00%	3	20.00%	2	0.00%	0	10
7	Share documents via removable storage devices - i.e. USB keys	20.00%	2	60.00%	6	20.00%	2	0.00%	0	0.00%	0	10
8	Connect/disconnect from a wireless network	10.00%	1	30.00%	3	40.00%	4	20.00%	2	0.00%	0	10
9	Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System	0.00%	0	30.00%	3	20.00%	2	40.00%	4	10.00%	1	10
10	Setup a wireless printer	0.00%	0	0.00%	0	40.00%	4	60.00%	6	0.00%	0	10
11	Create/delete a folder	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
12	Connect to Cloud storage	0.00%	0	40.00%	4	50.00%	5	10.00%	1	0.00%	0	10
13	Add/remove programs/apps	0.00%	0	10.00%	1	**90.00%**	9	0.00%	0	0.00%	0	10

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14	Map a network drive	0.00%	0	0.00%	0	10.00%	1	70.00%	7	20.00%	2	10
15	Design and install an office network	0.00%	0	0.00%	0	0.00%	0	40.00%	4	60.00%	6	10
16	Restart a frozen/locked up computer	10.00%	1	10.00%	1	60.00%	6	20.00%	2	0.00%	0	10
17	Enter, change, save BIOS settings	0.00%	0	10.00%	1	0.00%	0	20.00%	2	70.00%	7	10
18	Add hardware - i.e. new hard drive, CD/DVD, media card reader	0.00%	0	10.00%	1	0.00%	0	50.00%	5	40.00%	4	10
19	Format a hard drive	0.00%	0	0.00%	0	20.00%	2	30.00%	3	50.00%	5	10
20	Format removable storage device - i.e. USB drives/keys, SD cards	0.00%	0	10.00%	1	40.00%	4	40.00%	4	10.00%	1	10

Word Processing Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Formatting text	70.00%	7	30.00%	3	0.00%	0	0.00%	0	0.00%	0	10
2	Copy & Paste	70.00%	7	30.00%	3	0.00%	0	0.00%	0	0.00%	0	10
3	Set tabs	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
4	Set margins	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
5	Create table	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
6	Add a new source for bibliography and create bibliography	0.00%	0	10.00%	1	60.00%	6	30.00%	3	0.00%	0	10
7	Add header or footer	0.00%	0	50.00%	5	40.00%	4	10.00%	1	0.00%	0	10
8	Create a Blog post	0.00%	0	0.00%	0	40.00%	4	60.00%	6	0.00%	0	10
9	Insert an Online Video	0.00%	0	0.00%	0	60.00%	6	40.00%	4	0.00%	0	10
10	Insert Page Number and Page Breaks	0.00%	0	30.00%	3	70.00%	7	0.00%	0	0.00%	0	10
11	Generate a Table of Contents	0.00%	0	0.00%	0	40.00%	4	60.00%	6	0.00%	0	10
12	Format with Styles	0.00%	0	40.00%	4	10.00%	1	30.00%	3	20.00%	2	10
13	Work in Read Mode View	10.00%	1	20.00%	2	50.00%	5	20.00%	2	0.00%	0	10
14	Find and replace text	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
15	Track and review changes	0.00%	0	0.00%	0	60.00%	6	40.00%	4	0.00%	0	10
16	Lock and Unlock Tracking	0.00%	0	0.00%	0	60.00%	6	40.00%	4	0.00%	0	10
17	Change line spacing in a paragraph	0.00%	0	60.00%	6	40.00%	4	0.00%	0	0.00%	0	10

Spreadsheet Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Find and open an existing document	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
2	Turn on text wrapping	0.00%	0	**90.00%**	9	10.00%	1	0.00%	0	0.00%	0	10
3	Enter data into spreadsheet	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
4	Enter simple formulas such as MAX, SUM, MIN and AVG	10.00%	1	50.00%	5	30.00%	3	10.00%	1	0.00%	0	10
5	Create charts or graphs	0.00%	0	30.00%	3	50.00%	5	20.00%	2	0.00%	0	10
6	Sort and Filter data	0.00%	0	20.00%	2	50.00%	5	20.00%	2	10.00%	1	10
7	Add rows or columns	10.00%	1	70.00%	7	20.00%	2	0.00%	0	0.00%	0	10
8	Change font and size	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
9	Add cell borders and shading	0.00%	0	70.00%	7	30.00%	3	0.00%	0	0.00%	0	10
10	Apply conditional formatting	0.00%	0	10.00%	1	40.00%	4	50.00%	5	0.00%	0	10
11	Change height and width of rows and columns	0.00%	0	60.00%	6	40.00%	4	0.00%	0	0.00%	0	10
12	Freeze column and row titles	0.00%	0	0.00%	0	**80.00%**	8	20.00%	2	0.00%	0	10
13	Clear or delete cells	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
14	Find/replace data	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
15	Add a worksheet and rename	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
16	Filter and sort table information	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10

17	Link formulas/functions between worksheets	0.00%	0	0.00%	0	40.00%	4	50.00%	5	10.00%	1	10
18	Change Page Setup options	0.00%	0	**90.00%**	9	10.00%	1	0.00%	0	0.00%	0	10
19	Understand Formulas and Functions	0.00%	0	20.00%	2	40.00%	4	40.00%	4	0.00%	0	10
20	Error checking and trace error	0.00%	0	0.00%	0	20.00%	2	70.00%	7	10.00%	1	10
21	Format chart objects	0.00%	0	0.00%	0	50.00%	5	50.00%	5	0.00%	0	10
22	Create and use Macros	0.00%	0	0.00%	0	0.00%	0	60.00%	6	40.00%	4	10
23	Create and use Pivot Tables	0.00%	0	0.00%	0	0.00%	0	50.00%	5	50.00%	5	10
24	Upload to cloud	0.00%	0	30.00%	3	70.00%	7	0.00%	0	0.00%	0	10
25	Format data as a table	0.00%	0	50.00%	5	30.00%	3	20.00%	2	0.00%	0	10
26	Use fill handle to copy cells	30.00%	3	30.00%	3	40.00%	4	0.00%	0	0.00%	0	10
27	Use database functions (sort, query, mail merge, etc..	0.00%	0	10.00%	1	30.00%	3	40.00%	4	20.00%	2	10

Database Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Create a new database	60.00%	6	40.00%	4	0.00%	0	0.00%	0	0.00%	0	10
2	Find and open existing document	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
3	Create a new table	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
4	Use database functions (sort, query, mail merge)	0.00%	0	20.00%	2	30.00%	3	50.00%	5	0.00%	0	10
5	Hide a field	0.00%	0	30.00%	3	50.00%	5	20.00%	2	0.00%	0	10
6	Create a form	0.00%	0	40.00%	4	40.00%	4	20.00%	2	0.00%	0	10
7	Change font and size	40.00%	4	60.00%	6	0.00%	0	0.00%	0	0.00%	0	10
8	Change form views	20.00%	2	30.00%	3	50.00%	5	0.00%	0	0.00%	0	10
9	Move or delete fields	0.00%	0	60.00%	6	40.00%	4	0.00%	0	0.00%	0	10
10	Import/export data	0.00%	0	10.00%	1	50.00%	5	40.00%	4	0.00%	0	10
11	Add a record to a table and form	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
12	Navigate records in a form	30.00%	3	30.00%	3	40.00%	4	0.00%	0	0.00%	0	10
13	Search for a record using a form	0.00%	0	50.00%	5	30.00%	3	20.00%	2	0.00%	0	10
14	Sort and filter records	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
15	Apply conditional formatting	0.00%	0	20.00%	2	40.00%	4	40.00%	4	0.00%	0	10
16	Perform a query	0.00%	0	20.00%	2	30.00%	3	50.00%	5	0.00%	0	10
17	Create a report	0.00%	0	20.00%	2	30.00%	3	50.00%	5	0.00%	0	10
18	Enter data into an existing database	50.00%	5	40.00%	4	0.00%	0	10.00%	1	0.00%	0	10

Presentation Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Delete a slide	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
2	Create a photo album presentation	0.00%	0	30.00%	3	50.00%	5	20.00%	2	0.00%	0	10
3	Insert slides	40.00%	4	60.00%	6	0.00%	0	0.00%	0	0.00%	0	10
4	Change content in a presentation	40.00%	4	40.00%	4	20.00%	2	0.00%	0	0.00%	0	10
5	Preview a slide show	70.00%	7	20.00%	2	10.00%	1	0.00%	0	0.00%	0	10
6	Add and Edit a Slide show	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
7	Apply a theme	10.00%	1	70.00%	7	20.00%	2	0.00%	0	0.00%	0	10
8	Set line Spacing	20.00%	2	40.00%	4	40.00%	4	0.00%	0	0.00%	0	10
9	Insert, size and move clip art	0.00%	0	70.00%	7	20.00%	2	10.00%	1	0.00%	0	10
10	Add text boxes	10.00%	1	50.00%	5	30.00%	3	10.00%	1	0.00%	0	10
11	Add a video clip to a slide	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
12	Move a slide object	20.00%	2	60.00%	6	10.00%	1	10.00%	1	0.00%	0	10
13	Add sound and video to slides	0.00%	0	0.00%	0	60.00%	6	40.00%	4	0.00%	0	10
14	Animate objects (tables, charts, clip art, etc..)	0.00%	0	0.00%	0	70.00%	7	30.00%	3	0.00%	0	10
15	Reorganize slides	0.00%	0	50.00%	5	50.00%	5	0.00%	0	0.00%	0	10
16	Reuse a slide	0.00%	0	50.00%	5	30.00%	3	20.00%	2	0.00%	0	10

17	Define slide transitions	0.00%	0	30.00%	3	60.00%	6	10.00%	1	0.00%	0	10
18	Record narration	0.00%	0	10.00%	1	20.00%	2	60.00%	6	10.00%	1	10
19	Create speaker notes	10.00%	1	0.00%	0	70.00%	7	20.00%	2	0.00%	0	10
20	Run a slide show	40.00%	4	60.00%	6	0.00%	0	0.00%	0	0.00%	0	10
21	Create a self-running slideshow	0.00%	0	30.00%	3	50.00%	5	20.00%	2	0.00%	0	10
22	Present Online	0.00%	0	10.00%	1	40.00%	4	30.00%	3	20.00%	2	10
23	Copy presentation to USB or Cloud	10.00%	1	20.00%	2	60.00%	6	10.00%	1	0.00%	0	10

Email Communication Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Create a new contact	20.00%	2	60.00%	6	20.00%	2	0.00%	0	0.00%	0	10
2	Import/export contact list	0.00%	0	10.00%	1	70.00%	7	20.00%	2	0.00%	0	10
3	Include CC and BCC's to an email	30.00%	3	50.00%	5	20.00%	2	0.00%	0	0.00%	0	10
4	Schedule an appointment	0.00%	0	30.00%	3	60.00%	6	10.00%	1	0.00%	0	10
5	Invite attendees to an appointment	0.00%	0	20.00%	2	70.00%	7	10.00%	1	0.00%	0	10
6	Customize the Navigation Bar	0.00%	0	10.00%	1	30.00%	3	50.00%	5	10.00%	1	10
7	Search for e-mail items or people	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
8	Work with a to-do bar	0.00%	0	20.00%	2	70.00%	7	10.00%	1	0.00%	0	10
9	Link contacts	0.00%	0	0.00%	0	50.00%	5	50.00%	5	0.00%	0	10
10	Send a file attachment	10.00%	1	**80.00%**	8	10.00%	1	0.00%	0	0.00%	0	10
11	Reply to or forward a message	50.00%	5	40.00%	4	10.00%	1	0.00%	0	0.00%	0	10
12	Screen Junk mail	0.00%	0	20.00%	2	60.00%	6	20.00%	2	0.00%	0	10
13	Create rules for emails	0.00%	0	0.00%	0	40.00%	4	60.00%	6	0.00%	0	10
14	Mark email with high priority	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
15	Link other e-mail accounts to Outlook	0.00%	0	0.00%	0	0.00%	0	70.00%	7	30.00%	3	10

APPENDIX S

MODIFIED DELPHI METHOD STUDY – ROUND THREE RAW DATA

Modified Delphi Method Study - Round Three

Technology Literacy Definition

#	Technology Literacy Definition	Excellent		Good		Fair		Poor		N=
Q17	computer skills and the ability to use computers and other technology to improve learning, productivity, and performance [technology literacy] has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic.	30.00%	3	60.00%	6	10.00%	1	0.00%	0	10
Q18	the ability to responsibly use appropriate technology to: • Communicate • Solve problems • Access, manage, integrate, evaluate, design and create information to improve learning in all subject areas • Acquire lifelong knowledge and skills in the 21st century	50.00%	5	40.00%	4	10.00%	1	0.00%	0	10
Q19	an individual's abilities to adopt, adapt, invent, and evaluate technology to positively affect his or her life, community, and environment.	30.00%	3	60.00%	6	10.00%	1	0.00%	0	10

Q20	• An understanding of the concepts behind computing equipment, network connectivity, and application software; • The skills to responsibly use appropriate technology to access, synthesize, evaluate, communicate, and create information to solve problems and improve learning in all subject areas; and • The ability to acquire new knowledge for on-going and lifelong learning in the 21st	70.00%	7	30.00%	3	0.00%	0	0.00%	0	10
Q23	technology literacy and proficiency is the ability of an individual to use technology effectively, appropriately, and responsibly to acquire lifelong knowledge and skills.	20.00%	2	30.00%	3	50.00%	5	0.00%	0	10
Q24	the ability to gather, organize, analyze, and report information using technology.	20.00%	2	30.00%	3	30.00%	3	20.00%	2	10
Q25	the ability to responsibly use appropriate technology to communicate; solve problems; and access, manage, integrate, evaluate, design, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century.	50.00%	5	20.00%	2	30.00%	3	0.00%	0	10

Q26	the ability of students to use the tools of their society with skill in an ethical, accurate, and insightful manner to meet the demands of the 21st Century workplace and world. This includes the ability to use appropriate technology responsibly to solve problems and to create knowledge and learning by: accessing; managing; evaluating and analyzing; integrating and synthesizing; and communicating information.	60.00%	6	20.00%	2	20.00%	2	0.00%	0	10

Computer Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Copy/Delete a file	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
2	Retrieve a deleted file	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
3	Select appropriate software program	40.00%	4	30.00%	3	30.00%	3	0.00%	0	0.00%	0	10
4	Create a program/app shortcut on Desktop	10.00%	1	**60.00%**	6	20.00%	2	10.00%	1	0.00%	0	10
5	Pin a program/app to Task Bar	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	0.00%	0	10
6	Customize Personal Settings - i.e. screen resolution, change background, reorganize desktop icons	10.00%	1	40.00%	4	40.00%	4	10.00%	1	0.00%	0	10
7	Share documents via removable storage devices - i.e. USB keys	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
8	Connect/disconnect from a wireless network	0.00%	0	40.00%	4	50.00%	5	10.00%	1	0.00%	0	10
9	Can identify computer properties - i.e. amount of RAM, hard drive size (amount of used and free space), version of Operating System	0.00%	0	30.00%	3	10.00%	1	**60.00%**	6	0.00%	0	10
10	Setup a wireless printer	0.00%	0	0.00%	0	40.00%	4	**60.00%**	6	0.00%	0	10
11	Create/delete a folder	40.00%	4	**60.00%**	6	0.00%	0	0.00%	0	0.00%	0	10
12	Connect to Cloud storage	0.00%	0	**60.00%**	6	40.00%	4	0.00%	0	0.00%	0	10
14	Map a network drive	0.00%	0	10.00%	1	30.00%	3	40.00%	4	20.00%	2	10

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15	Design and install an office network	0.00%	0	0.00%	0	10.00%	1	20.00%	2	**70.00%**	7	10
16	Restart a frozen/locked up computer	10.00%	1	30.00%	3	50.00%	5	10.00%	1	0.00%	0	10
17	Enter, change, save BIOS settings	0.00%	0	0.00%	0	20.00%	2	0.00%	0	**80.00%**	8	10
18	Add hardware - i.e. new hard drive, CD/DVD, media card reader	0.00%	0	0.00%	0	10.00%	1	50.00%	5	40.00%	4	10
19	Format a hard drive	0.00%	0	10.00%	1	10.00%	1	40.00%	4	40.00%	4	10
20	Format removable storage device - i.e. USB drives/keys, SD cards	0.00%	0	30.00%	3	30.00%	3	30.00%	3	10.00%	1	10

Word Processing Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Formatting text	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
2	Copy & Paste	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
3	Set tabs	10.00%	1	**60.00%**	6	30.00%	3	0.00%	0	0.00%	0	10
4	Set margins	40.00%	4	30.00%	3	30.00%	3	0.00%	0	0.00%	0	10
5	Create table	10.00%	1	50.00%	5	30.00%	3	10.00%	1	0.00%	0	10
6	Add a new source for bibliography and create bibliography	0.00%	0	10.00%	1	**60.00%**	6	30.00%	3	0.00%	0	10
7	Add header or footer	0.00%	0	**70.00%**	7	20.00%	2	10.00%	1	0.00%	0	10
8	Create a Blog post	0.00%	0	0.00%	0	**60.00%**	6	40.00%	4	0.00%	0	10
9	Insert an Online Video	0.00%	0	0.00%	0	**70.00%**	7	30.00%	3	0.00%	0	10

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10	Insert Page Number and Page Breaks	0.00%	0	50.00%	5	50.00%	5	0.00%	0	0.00%	0	10
11	Generate a Table of Contents	0.00%	0	10.00%	1	20.00%	2	**70.00%**	7	0.00%	0	10
12	Format with Styles	0.00%	0	40.00%	4	30.00%	3	30.00%	3	0.00%	0	10
13	Work in Read Mode View	10.00%	1	40.00%	4	40.00%	4	10.00%	1	0.00%	0	10
14	Find and replace text	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10
15	Track and review changes	0.00%	0	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	10
16	Lock and Unlock Tracking	0.00%	0	10.00%	1	**60.00%**	6	30.00%	3	0.00%	0	10
17	Change line spacing in a paragraph	10.00%	1	**60.00%**	6	30.00%	3	0.00%	0	0.00%	0	10

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Spreadsheet Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
3	Enter data into spreadsheet	**90.00%**	9	10.00%	1	0.00%	0	0.00%	0	0.00%	0	10
4	Enter simple formulas such as MAX, SUM, MIN and AVG	0.00%	0	**70.00%**	7	30.00%	3	0.00%	0	0.00%	0	10
5	Create charts or graphs	0.00%	0	40.00%	4	50.00%	5	10.00%	1	0.00%	0	10
6	Sort and Filter data	0.00%	0	20.00%	2	**60.00%**	6	10.00%	1	10.00%	1	10
7	Add rows or columns	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
8	Change font and size	**80.00%**	8	10.00%	1	10.00%	1	0.00%	0	0.00%	0	10
9	Add cell borders and shading	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
10	Apply conditional formatting	0.00%	0	10.00%	1	50.00%	5	40.00%	4	0.00%	0	10
11	Change height and width of rows and columns	10.00%	1	**60.00%**	6	20.00%	2	10.00%	1	0.00%	0	10
13	Clear or delete cells	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
14	Find/replace data	10.00%	1	40.00%	4	50.00%	5	0.00%	0	0.00%	0	10
15	Add a worksheet and rename	20.00%	2	**70.00%**	7	10.00%	1	0.00%	0	0.00%	0	10
16	Filter and sort table information	10.00%	1	40.00%	4	30.00%	3	20.00%	2	0.00%	0	10
17	Link formulas/functions between worksheets	0.00%	0	10.00%	1	20.00%	2	**60.00%**	6	10.00%	1	10
19	Understand Formulas and Functions	0.00%	0	30.00%	3	40.00%	4	30.00%	3	0.00%	0	10
20	Error checking and trace error	0.00%	0	10.00%	1	30.00%	3	40.00%	4	20.00%	2	10

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21	Format chart objects	0.00%	0	10.00%	1	50.00%	5	40.00%	4	0.00%	0	10
22	Create and use Macros	0.00%	0	0.00%	0	10.00%	1	50.00%	5	40.00%	4	10
23	Create and use Pivot Tables	0.00%	0	0.00%	0	20.00%	2	20.00%	2	**60.00%**	6	10
24	Upload to cloud	0.00%	0	30.00%	3	50.00%	5	10.00%	1	10.00%	1	10
25	Format data as a table	10.00%	1	40.00%	4	20.00%	2	30.00%	3	0.00%	0	10
26	Use fill handle to copy cells	30.00%	3	**60.00%**	6	10.00%	1	0.00%	0	0.00%	0	10
27	Use database functions (sort, query, mail merge, etc..	0.00%	0	20.00%	2	30.00%	3	40.00%	4	10.00%	1	10

Database Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Create a new database	40.00%	4	50.00%	5	10.00%	1	0.00%	0	0.00%	0	10
3	Create a new table	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	0.00%	0	10
4	Use database functions (sort, query, mail merge)	0.00%	0	40.00%	4	30.00%	3	30.00%	3	0.00%	0	10
5	Hide a field	0.00%	0	50.00%	5	50.00%	5	0.00%	0	0.00%	0	10
6	Create a form	20.00%	2	20.00%	2	50.00%	5	10.00%	1	0.00%	0	10
7	Change font and size	50.00%	5	50.00%	5	0.00%	0	0.00%	0	0.00%	0	10
8	Change form views	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
9	Move or delete fields	10.00%	1	50.00%	5	40.00%	4	0.00%	0	0.00%	0	10

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10	Import/export data	0.00%	0	20.00%	2	50.00%	5	30.00%	3	0.00%	0	10
11	Add a record to a table and form	20.00%	2	50.00%	5	30.00%	3	0.00%	0	0.00%	0	10
12	Navigate records in a form	40.00%	4	40.00%	4	20.00%	2	0.00%	0	0.00%	0	10
13	Search for a record using a form	10.00%	1	**60.00%**	6	20.00%	2	10.00%	1	0.00%	0	10
14	Sort and filter records	10.00%	1	40.00%	4	40.00%	4	10.00%	1	0.00%	0	10
15	Apply conditional formatting	0.00%	0	10.00%	1	50.00%	5	40.00%	4	0.00%	0	10
16	Perform a query	10.00%	1	10.00%	1	40.00%	4	40.00%	4	0.00%	0	10
17	Create a report	10.00%	1	20.00%	2	30.00%	3	40.00%	4	0.00%	0	10
18	Enter data into an existing database	**60.00%**	6	30.00%	3	0.00%	0	10.00%	1	0.00%	0	10

Presentation Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Delete a slide	**70.00%**	7	20.00%	2	10.00%	1	0.00%	0	0.00%	0	10
2	Create a photo album presentation	0.00%	0	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	10
3	Insert slides	50.00%	5	40.00%	4	10.00%	1	0.00%	0	0.00%	0	10
4	Change content in a presentation	30.00%	3	**70.00%**	7	0.00%	0	0.00%	0	0.00%	0	10
5	Preview a slide show	40.00%	4	**60.00%**	6	0.00%	0	0.00%	0	0.00%	0	10
6	Add and Edit a Slide show	10.00%	1	**70.00%**	7	20.00%	2	0.00%	0	0.00%	0	10
7	Apply a theme	10.00%	1	**80.00%**	8	10.00%	1	0.00%	0	0.00%	0	10

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8	Set line Spacing	20.00%	2	**70.00%**	7	10.00%	1	0.00%	0	0.00%	0	10
9	Insert, size and move clip art	10.00%	1	**60.00%**	6	20.00%	2	10.00%	1	0.00%	0	10
10	Add text boxes	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	0.00%	0	10
11	Add a video clip to a slide	0.00%	0	30.00%	3	50.00%	5	10.00%	1	10.00%	1	10
12	Move a slide object	20.00%	2	50.00%	5	20.00%	2	10.00%	1	0.00%	0	10
13	Add sound and video to slides	0.00%	0	10.00%	1	**60.00%**	6	20.00%	2	10.00%	1	10
14	Animate objects (tables, charts, clip art, etc..)	0.00%	0	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	10
15	Reorganize slides	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	0.00%	0	10
16	Reuse a slide	20.00%	2	50.00%	5	20.00%	2	10.00%	1	0.00%	0	10
17	Define slide transitions	0.00%	0	40.00%	4	30.00%	3	30.00%	3	0.00%	0	10
18	Record narration	0.00%	0	0.00%	0	30.00%	3	50.00%	5	20.00%	2	10
19	Create speaker notes	0.00%	0	20.00%	2	**60.00%**	6	20.00%	2	0.00%	0	10
20	Run a slide show	20.00%	2	**80.00%**	8	0.00%	0	0.00%	0	0.00%	0	10
21	Create a self-running slideshow	0.00%	0	10.00%	1	**60.00%**	6	30.00%	3	0.00%	0	10
22	Present Online	0.00%	0	0.00%	0	50.00%	5	30.00%	3	20.00%	2	10
23	Copy presentation to USB or Cloud	10.00%	1	30.00%	3	**60.00%**	6	0.00%	0	0.00%	0	10

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Email Communication Skills

#	Question	Novice		Advanced Beginner		Competent		Proficient		Expert		N
1	Create a new contact	30.00%	3	**60.00%**	6	10.00%	1	0.00%	0	0.00%	0	10
2	Import/export contact list	0.00%	0	20.00%	2	**70.00%**	7	10.00%	1	0.00%	0	10
3	Include CC and BCC's to an email	10.00%	1	**80.00%**	8	10.00%	1	0.00%	0	0.00%	0	10
4	Schedule an appointment	0.00%	0	**60.00%**	6	30.00%	3	10.00%	1	0.00%	0	10
5	Invite attendees to an appointment	0.00%	0	50.00%	5	40.00%	4	10.00%	1	0.00%	0	10
6	Customize the Navigation Bar	0.00%	0	30.00%	3	40.00%	4	10.00%	1	20.00%	2	10
7	Search for e-mail items or people	10.00%	1	**80.00%**	8	10.00%	1	0.00%	0	0.00%	0	10
8	Work with a to-do bar	0.00%	0	40.00%	4	40.00%	4	10.00%	1	10.00%	1	10
9	Link contacts	0.00%	0	0.00%	0	**70.00%**	7	30.00%	3	0.00%	0	10
11	Reply to or forward a message	**80.00%**	8	20.00%	2	0.00%	0	0.00%	0	0.00%	0	10
12	Screen Junk mail	0.00%	0	**60.00%**	6	20.00%	2	20.00%	2	0.00%	0	10
13	Create rules for emails	0.00%	0	10.00%	1	40.00%	4	20.00%	2	30.00%	3	10
14	Mark email with high priority	20.00%	2	30.00%	3	40.00%	4	10.00%	1	0.00%	0	10
15	Link other e-mail accounts to Outlook	0.00%	0	0.00%	0	40.00%	4	30.00%	3	30.00%	3	10

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APPENDIX T

INTEGRATION QUESTIONNAIRE – RESPONSES

Course - Integration questionnaire responses

how feasible do you feel the integration of the ATLAS within one of your courses?	I think it would be feasible. The courses I am currently teaching would not have a strong need for spreadsheet or data base knowledge, but it would be easy to just put TL-1 for those areas.
what policies and procedures would need to be adhered to in order to integrate the ATLAS within one of your courses?	Do you mean university policies and procedures? I think I would still have to let students take my course who had limited technological proficiency. So I could not use ATLAS to prevent someone from taking my course. This would be different in a course that was primarily technology based (e.g., design). However, it could provide a baseline for those entering the course.
what challenges do you foresee with integrating the ATLAS within one of your courses?	I wonder if students might be deterred from taking the course if there is a higher ATLAS rating (e.g., they could underrate their own knowledge). They may be capable, but are intimated because they think others have a stronger knowledge in the areas. I could see this (from my experience) being especially true for non-traditional students. Another challenge may be that I offer assignment choices in my class. Some of the assignment choices would require a higher TL in some areas -- so for my course one TL for each area would not be completely accurate and setting a higher TL may prevent some students from taking it when they could do fine (based on their assignment choice) in the class with a lower TL.
what advantages do you foresee with integrating the ATLAS within one of your courses?	ATLAS could be another point for students to evaluate their preparedness for the class. It may also help them realize why they might be struggling in a class and they could figure out areas they could enhance their technological knowledge. ATLAS could also be introduced in a freshmen course to make sure that students have these skills.

what opportunities do you foresee with integrating the ATLAS within one of your courses?	I could see some of my courses that are research intensive benefiting from ATLAS. Formatting papers (references; headings, running heads) always seem to be a problem. ATLAS could be a formal way of helping students know they need this skill.
do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within one of your courses?	I think it wouldn't be too challenging for me personally. However, some of my colleagues would struggle. They would need someone to train them and would probably like assistance in implementing it in their course.
what value would you place on the integration of the ATLAS within your college as a whole?	It could be most helpful in my uppder division course offerings when there are greater technology expectations. I think standardizing TL could be helpful across programs.

Department - Integration questionnaire responses

how feasible do you feel the integration of the ATLAS within one of your courses?	I think it is highly feasible. I would be interested in what testing you used to create the rubric. Specifically, what was your process to identify which skills within the "computer" designation were selected to be "novice" compared to those that were "competent".
what policies and procedures would need to be adhered to in order to integrate the ATLAS within one of your courses?	This would be an optional component that faculty could choose to add to their syllabi or other course welcome materials.
what challenges do you foresee with integrating the ATLAS within one of your courses?	I think faculty would struggle to identify which level to specify. I can envision greater adoption if they were able to "check off" the specific skills within a specific domain (like computer) a student would need competence.
what advantages do you foresee with integrating the ATLAS within one of your courses?	It would be valuable to share with students which technological skills they will be required to have (or develop) for a course. Students are beginning to ask whether their coursework and approach to learning is relevant to the work world. It would be helpful for faculty to think through how they use technology and what level of proficiency and competence they expect of students.
what opportunities do you foresee with integrating the ATLAS within one of your courses?	Again, I don't see the utility of ATLAS in its rubric fashion. I think its greatest opportunity is for faculty to "check off" the technological skills needed for success in the course.
do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within one of your courses?	No
what value would you place on the integration of the ATLAS within your college as a whole?	I think the value is in thinking through the different domains of technological skills required in our courses (Computer, Database, Spreadsheet, Presentation, etc.) and the specific skills associated with each. I think it could be a valuable diagnostic tool for faculty to self-assess their own technological competence along with helping them to position their course in terms of its technology expectations accordingly.

College - Integration questionnaire responses

how feasible do you feel the integration of the ATLAS within one of your courses?	Feasible
what policies and procedures would need to be adhered to in order to integrate the ATLAS within one of your courses?	I think we would need to convene the directors, dean and curriculum committees (maybe all faculty) to describe the ATLAS and inform them of the importance of technological literacy in our college and why this is an important assessment tool and a way to determine our students prior knowledge.
what challenges do you foresee with integrating the ATLAS within one of your courses?	The biggest challenges will be around faculty feeling technology illiterate and unsure if they are qualified to be part of this or have it in their unit.
what advantages do you foresee with integrating the ATLAS within one of your courses?	I think we assume our students have technology literacy because of their age, but our students are often less literate than we are, especially with the advent of touchscreen apps. It is important we understand what it means to be technology literate and this could serve as a quality assurance tool for faculty, staff and students alike.
what opportunities do you foresee with integrating the ATLAS within one of your courses?	Interesting, I think the same as the last question. But to add to it, this is an opportunity for us to determine our own levels of technology literacy and an opportunity to improve our abilities.
do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within one of your courses?	I think some training will have to come with rolling it out and then maybe access to help, similar to Brightspace help, as people forget how to integrate details of the Atlas or as new faculty are hired.
what value would you place on the integration of the ATLAS within your college as a whole?	I think it would be very valuable.

University - Integration questionnaire responses

how feasible do you feel the integration of the ATLAS within one of your courses?	not feasible
what policies and procedures would need to be adhered to in order to integrate the ATLAS within one of your courses?	We would need to create new policies and procedures
what challenges do you foresee with integrating the ATLAS within one of your courses?	Time would be the major challenge. Other priorities would be the second. Faculty, department heads, deans want to be involved in the design of new requirements and would need to help write rubrics. Faculty and department heads have other needs that may be more pressing. For example, assessment of curriculum and programs for accreditation may receive more attention from administration. We would not require the use of ATLAS rubrics but could make them optional for departments/programs to develop and may be more popular for some disciplines than others
what advantages do you foresee with integrating the ATLAS within one of your courses?	Students would know what skills are needed for a course and faculty would know the technology entry level of students
what opportunities do you foresee with integrating the ATLAS within one of your courses?	Students would know what technology skills are needed for a course, know what gaps they have, and therefore be able reduce the gaps and come to class better prepared to be successful.
do you foresee any additional resources (fiscal and/or personnel) needed to integrate the ATLAS within one of your courses?	Yes - adding personal costs money. A graduate student in each department could perhaps work with the faculty in a department to create this - but they too cost money.
what value would you place on the integration of the ATLAS within your college as a whole?	This would be valuable but difficult to integrate within the university

Comments - University

ATLAS might be more successful in implementing institution wide at a smaller institution or an institution with a different mission. For example, a community college with many entering adult students who have been out college for years may find more success in getting ATLAS integrated.

APPENDIX U

TECHNOLOGY LITERACY DEFINITIONS – 1978-1989

Technological literacy is:

- "an understanding of the application of science and engineering to the solution of concrete problems." (Miller, 1986, p. 5).
- "the possession of a broad knowledge of technology, together with the necessary attitudes and physical abilities to implement the knowledge in a safe, appropriate, efficient, and effective manner. Technological literacy requires that one be able to perform appropriate tasks using the tools, machines, materials, and processes of technology. Industrial technological literacy, a subset of technological literacy, may be defined as 'the ability to understand, appreciate and efficiently make and use the man made world'" (Lux, 1978).
- "the qualities which permit a person to interact successfully with technology. These include: consumer/user skills, technical skills, the ability to assess the impact of technology on everyday life, the ability to understand issues in a democratic technological society, the ability to apply conceptual knowledge to the solution of technical problems, and a knowledge of career opportunities in technologically-related fields of endeavor" (NYS, 1984, p.5).
- "an understanding of the systems of technology" (Jones, 1984, p.8).
- "the ability to function as knowledgeable citizens in our increasingly technological world" (Peckham, September, 1989).
- the creation, use and control of technical means is embedded in the social, economic and political fabric of our society" (Bowden, 1982, p. 9 in DeVore, 1987, p. 13).
- "the issue is the understanding and control of the behavior of technological systems as a major component of social systems and as a critical factor in cultural change and disruption within societies" DeVore (1987, p. 22).
- intended to "control technical means by intelligent socially sensitive human beings" (DeVore, 1987, ITEA).
- technology and the teaching of values. The AAHE Bulletin, pp. 8-10, cited the 1983 Atlantic Council Policy paper which stressed "that today's youth 'must understand the need, uses, and limitations of technological knowledge and the challenges to traditional values technology can pose. How can they use technology for humane purposes and not be overshadowed by it?'" (Billington, December, 1985, p. 8).
- to "integrate work and life," to "provide flexibility and mobility of both skills and of geography," and to find a "set of meaningful values" (Deforge, 1981).
- an ability to experience, observe, examine, draw and design things for and from the environment. As a result, young people should be able to:
  - understand the steps in a process
  - develop mental images/ideas into forms that they can see and react to
  - look at the physical world in alternative ways (Smalley, n.d.)
- "the possession of a broad knowledge of technology together with the attitudes and physical abilities to implement the knowledge in a safe, appropriate, efficient, and effective manner. Technological literacy requires that one be able to perform tasks using the tools, machines, materials and processes resulting from technology" (Dyrenfurth, 1984).