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The Coin of the Realm: Identifying the Information and Communication Technology (ICT) Skill Requirements of Twenty-First Century Occupations

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Identifying the Information and Communication Technology (ICT) Skill Requirements of Twenty-First Century Occupations

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EXECUTIVE SUMMARY

This report presents the findings from a novel survey instrument developed for a client-based project completed in Spring 2016 with the nonprofit educational organization ACT, Inc. The pilot study collects and analyzes survey data from 482 workers in the U.S. labor force, who were asked to identify the likelihood that their current job would require specific *information and communication technology* skills (ICTs) on day one, with no on-the-job training. Drawing from the literature in education, communications theory, sociology and economics, the study seeks to test the strength and direction of the relationship between ICT skills and respondents' specific jobs. The motivation for this research is to understand the importance of these data and its potential role in the development of curricular frameworks that teach twenty-first century skills. Within the education policy arena, the theory of action for such frameworks is that they are typically designed to improve college- and career-readiness via compulsory schooling during the K-12 years and into one's career.

Using descriptive statistics, the findings from the pilot study indicate a mean composite score across all ICT sub-skills and Bureau of Labor Statistics/O*NET job zones as 2.88 out of 4. Using inferential measures of association, a statistically significant and positive correlation between the average ICT skill required in jobs and job zone category is found, with a particular emphasis on the higher ICT skills expected by employers of workers in certain "in-demand" jobs, typically found in job zones 3 and 4: accountants, computer scientists, educators, engineers and paralegals. Lower than average ICT skills are also found among workers in other in-demand jobs, such as nurses and members of the military.

These findings, and the survey model developed, have the potential to inspire further research (by ACT and other organizations) into the role that technology and information literacy plays in equipping the U.S. workforce for twenty-first century job requirements. While the deployment of this pilot survey on Amazon Mechanical Turk suggests limited generalizability to full U.S. population, it also invites a perspective on implications for public policy and management. Two of these recommendations are to provide more effective and earlier training and curricular programming related to ICT skills for K-12 students, and to consider ways to refine and test the O*NET job zones for possible improvement to the alignment between the ICT skill requirements listed and real-world expectations by employers.

Keywords: information and communication technologies, ICTs, twenty-first century skills, college- and career-readiness, CCR, workforce development, cognitive skills, critical thinking skills, problem solving skills, technology-rich environments, O*NET, job zones, public policy, management.

CONTENTS

1 INTRODUCTION: DEFINING THE POLICY PROBLEM

The U.S. labor force has rebounded strongly from the global economic crisis of 2007-09, prompting declarations from scholars and pundits alike that the Great Recession is finally over (Krugman, 2014; Worstall, 2015). The national unemployment rate is hovering at five percent, formerly stagnant wages are on the rise (Schwartz, 2016) and the Bureau of Labor Statistics (2015) predicts that the American workforce will grow by 9.8 million jobs before 2024.

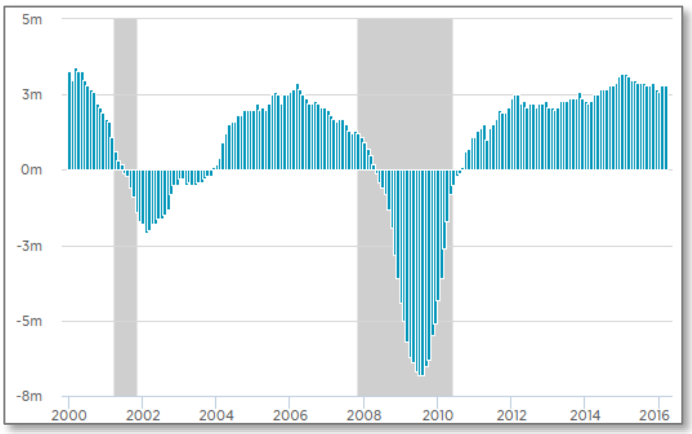

Figure 1. Year-over-year change in job growth, 2000-2016.
Gray bars indicate years of recession.
Source: Bureau of Labor Statistics, in Wells & Fahey (2016)

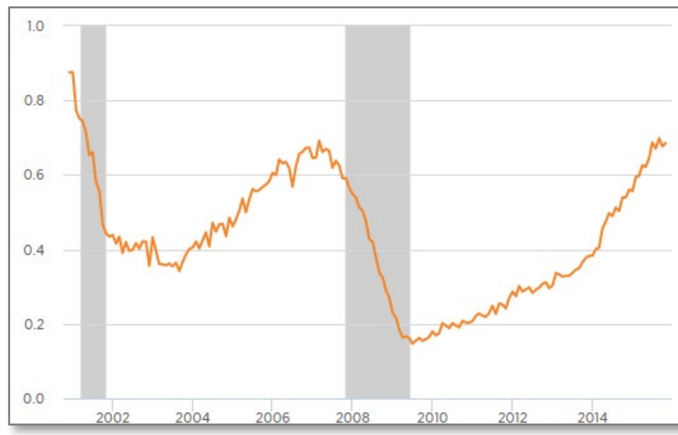

Figure 2. Ratio of job vacancies to unemployed workers, 2001-2016. Gray bars indicate years of recession.
Source: St. Louis Federal Reserve, in Wells & Fahey (2016)

However, this recent influx of good news belies a harsh reality facing some American workers: many of the projected jobs will demand higher skill levels than they currently possess. The BLS-funded O*NET occupational resource describes five *job zones* (1-5) organized by "how much education, related experience and on-the-job training people need to do the work" required of that particular occupation (U.S. Department of Labor, 2015). Economists predict that 65% of the workforce (*see Figure 3*) will need "training beyond high school" (job zones 3-5) to align their skill level with the requirements of these future jobs (Carnevale, Smith, & Strohl, 2013). Yet only 42% of Americans earn at least an Associate's degree by the age of twenty-five, according to current educational attainment data from the U.S. Census (2015).

If these postsecondary education trends continue and the nation's employers also continue adding high-skill jobs, some workers—those who do not seek an academic credential or

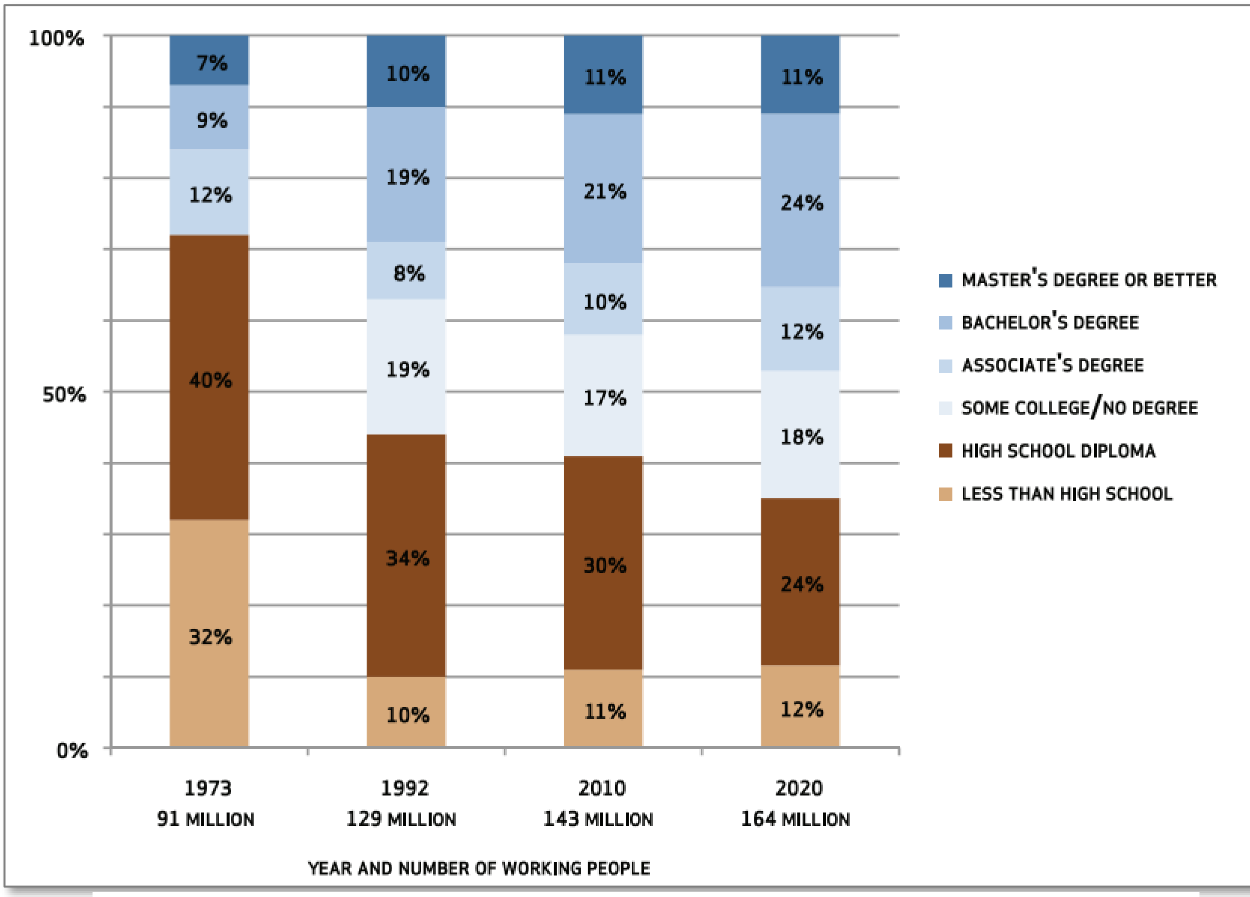

Figure 3. Historical and projected educational requirements for employment, 1973-2020.
Source: Center for Education and the Workforce (2013)

vocational certification beyond a high school diploma—may be displaced from middle-skill jobs. They will have missed an earlier opportunity to position themselves for the higher wages and better career outcomes that correspond to the upper-level job zones, and would be under-qualified for the majority of the skill-rich positions that employers will offer in the future. This is the policy problem that the current capstone project seeks to remedy.

One way to foreclose on this potential policy problem is to ensure that K-12 students *do* have an opportunity to learn high-level skills while completing their compulsory schooling, regardless of their college aspirations. With the aforementioned labor market concerns as a backdrop, the concept of *information and communication technology* (ICT) skills—once an abstract construct used mainly by academics in sociology and communication theory—has recently emerged in conversations among education reformers as an increasingly vital and relevant skill with additional applicability to workforce development (Goldin & Katz, 2008; Binkley, et al., 2015). International policy analysts and practitioners alike have linked the concept to the development of curricular frameworks for early childhood and secondary education (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014; ECDL Foundation, 2015), but the idea that American school districts should focus on ICT skills and "information literacy"—among other cognitive and non-content-specific skills—has only slowly become part of the broader College- and Career-Readiness accountability movement in the United States (USDOE, 2014). This movement preaches the necessity of inculcating students with the "twenty-first century skills" needed to succeed in a world that is constantly being mediated by technology (Pellizzari & Fichen, 2013) and in jobs that will increasingly take place in "technology-rich [work] environments" (National Center for Education Statistics, 2013).

This research study offers one possible avenue for exploring the extent of alignment between workers' technology and computer skills and the potential career paths that they may choose. The project seeks to answer the following research question:

- "What is the relationship between the information and communication technology (ICT) skills actually required of workers' jobs and the different job zones that these workers inhabit?"

To test the strength of this relationship, the author (in collaboration with a client, ACT) developed a pilot survey instrument exclusively for this capstone project. The survey's sample selection and methodology is focused on workers from all sectors of the U.S. labor market, each with a baseline familiarity of computer use and the Internet but whose employers likely had differing expectations about how their employees should communicate about information using technology as a function of their job's explicit requirements. The essential question asked on the survey is about the *likelihood* that the respondent's specific job would require certain ICT skills in the context of their work responsibilities. An analysis of the survey responses follows the methodology section, drawing from the existing published literature on the importance of ICT skills, as well as the U.S. Department of Labor's occupational databases and the client's own proprietary research that it uses to produce assessment instruments and curricular frameworks. The findings from this analysis offer a preliminary understanding of the relationship between ICT skills and real-world job requirements in the United States. This information could be a critical cog in developing education policy recommendations about curricula to teach ICTs as a twenty-first century skill, and could also inform the way that employers and professional associations specify the skills they expect new hires to bring to their employment in the future.

2 BACKGROUND

To situate the capstone in the broader context of current public policy and relevant published research, this background will discuss three interrelated concepts: (1) the College- and Career-Readiness movement and how it uses accountability to ensure that schools teach twenty-first century skills; (2) the client, ACT, and how it conceives of ICTs as a "technology and information literacy" that fits within the umbrella of twenty-first century skills; and (3) the availability of official data from the U.S. Department of Labor and the U.S. Census concerning the knowledge, skills and abilities (including ICT skills) required for employment in different job zones and families.

2.1 College- and Career-Readiness and Twenty-First Century Skills

The College- and Career-Readiness (CCR) accountability movement is one response by policymakers to the labor market issues discussed in the introduction. CCR's theory of action is designed to improve the skills of the future labor force by ensuring that the teaching and learning in K-12 schools is systematic and rigorous. This effort has taken root across the United States education policy arena, largely at the federal and state levels, as a means to develop higher standards for student learning across critical content areas (Mattern, et al., 2014; USDOE, 2014). Advocates of this movement preach the necessity of inculcating students with the "twenty-first century skills" and abilities needed to succeed in their careers, whether they decide to attend college or not.

The fundamental assumption of the CCR movement is that measures of "readiness" can be derived from a series of benchmarks and standards, leveraged by legal requirements imposed on schools to formally evaluate students' learning at key checkpoints in their progress from kindergarten to high school graduation (Darling-Hammond, 2006; McDermott, 2011). The increasing reliance on high-stakes assessments to verify student progress in core content areas has created a culture of accountability for schools that receive federal and state aid. It has also paved the way for the majority of U.S. states to develop a standard set of curricula for two traditional school subjects, English language arts and mathematics, which have been codified in the Common Core State Standards.

The prolonged interest in CCR within policy circles, while only leading to meaningful standards in these two subjects, has more recently led to questions about whether other areas of learning—not just other subject areas like civics and science, but also more broadly applicable cognitive (Carnevale, Smith, & Strohl, 2013) and non-cognitive skills (García, 2014)—should be baked into these standards. Decades of research have shown that these competencies can also serve as valid and reliable predictors of postsecondary and workplace success, and that earlier interventions to develop cognitive and non-cognitive skills predict other positive outcomes like college retention, job satisfaction and job performance (Mattern, et al., 2014).

Enforcement of federal and state content standards is another matter. The defining characteristic of the U.S. education system is its historical dependence on localism (Jennings, 2015; Reed, 2014; McDermott, 1999). Local control means that even as a vast majority of government services have become more centralized over the last fifty years, administration of compulsory academic services remains largely decentralized. Today there are more than 13,000 distinct school districts across America (National Center for Education Statistics, 2012). Important decisions—about everything from funding priorities to curricular content—are ultimately governed at the district level by local school boards. Efforts by state and federal government actors to promulgate regulations and policies that promote a more nationalized and often reform-based agenda have been met with skepticism and vigorous resistance by those who wish to defend the tenets of localism (Gamson, McDermott, & Reed, 2015; McDermott, 2011). Yet despite the reservations of some educators, federal policymakers have successfully used a mixture of inducements and mandates—such as reauthorizations of the Elementary and Secondary Education Act of 1965 and, more recently, the Race to the Top grant program—to ensure that state and local educational agencies conform to CCR-based initiatives such as the Common Core, and that they are accountable for the curriculum they offer in schools.

The College- and Career-Readiness movement is relevant to this study because it is one possible vehicle by which information and communication technology skills could be more systematically and sustainably taught to K-12 students. If national and statewide educators can succeed in incorporating ICTs into the curricular frameworks that already teach the other twenty-first century skills currently being emphasized in schools, it is reasonable to expect that a larger number of students would gain experience with ICTs and become even more ready for college and career. This study sets up the possibility of identifying a benchmark or target for the *appropriate* level of ICT skills that indicate "readiness," which could be adopted by the major assessment consortia and/or curriculum developers.

2.2 ACT, ICTs and the Holistic Framework

So, what exactly *are* ICTs? The Partnership for 21st Century Skills, a contributor to the College- and Career-Readiness movement and leading partner with twenty state education agencies (including Massachusetts) in developing curricular frameworks, defines an array of "information, media and technology skills" as tools for "citizens and workers ... to be effective in the 21st century" (Partnership for 21st Century Skills, 2012). It draws a distinction between pure information literacy and specifically ICT literacy, pointing out that ICT skills more frequently demand the use of electronic applications and resources, digital devices and other communication and networking technology as a compendium of the tools that help people "research, organize, evaluate and communicate information" and "access, manage, integrate, and create information to successfully function in a knowledge economy."

ACT, the client for this capstone, similarly defines ICT skills in terms of "acquisition" and "application" of information. They describe ICT skills as the ability to "research, collect, manage, transform and exchange information using technologies such as web browsers, email, word processing and spreadsheet software." Aside from its domestic partners, ACT's understanding of ICTs is also informed in part by numerous international studies and educational frameworks for technology literacy (ECDL Foundation, 2015; Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014; Pellizzari & Fichen, 2013). Among this international research is a multi-national longitudinal study led by the Organization for Economic Cooperation and Development (OECD), whose Survey of Adult Skills found that "fewer than half of U.S. 16-24 year olds scored above a basic proficiency level" on an assessment of problem-solving skills in "technology-rich environments" (National Center for Education Statistics, 2013; Pellizzari & Fichen, 2013). ACT merged these diverse inputs when it developed its own construct and benchmarks to measure ICT skills, cataloging the many sample statements and sub-skills that correspond to different levels of ability and attaching them to a scale for ICT ability (levels 1 through 4). Some of these statements now serve as items on the survey instrument created for this capstone.

ACT's interest in this topic stems from its long-standing involvement in the education sphere. ACT is a nonprofit organization based in Iowa City, IA. Most commonly associated with its eponymous college entrance exam, which has been administered in high schools for over 50 years, it has recently expanded its mission and vision to encompass a broader goal: to help people "achieve education and workplace success ... throughout their lifetimes" (About ACT, 2016). A major thrust of ACT's new "cradle to grave" approach is the sponsorship of research for its own purposes and for an audience of educators and business partners.

The Division of Assessment Design, headed by Dr. Wayne Camara, ACT's Senior Vice President of Research, has recently developed a series of working papers and reports to expand on its "Holistic Framework" initiative, which is an effort to broaden the definition of College- and Career-Readiness to include more cognitive and non-cognitive benchmarks. ACT's overriding goal is to establish a holistic approach to CCR that will better assist students and adults in identifying and navigating potential barriers at key transition points throughout the K-career continuum (Mattern, et al., 2014).

The Holistic Framework represents an effort to strengthen the knowledge base for academicians and research scientists who are interested in improving education practices. The Framework's four pillars underscore the need to support lifelong learning beyond K-12 schools' traditional focus on the core content areas, such as mathematics and English language arts, as discussed in the previous section. ACT believes that other skills—such as non-cognitive and behavioral skills, so-called "cross-cutting capabilities," and the knowledge to navigate one's path through college and career—must be fortified as well (Mattern, et al., 2014; Camara, O'Connor, Mattern, & Hanson, 2015). The Framework is geared toward practitioners and organizations who wish to empower individuals seeking to improve their readiness for college and career success.

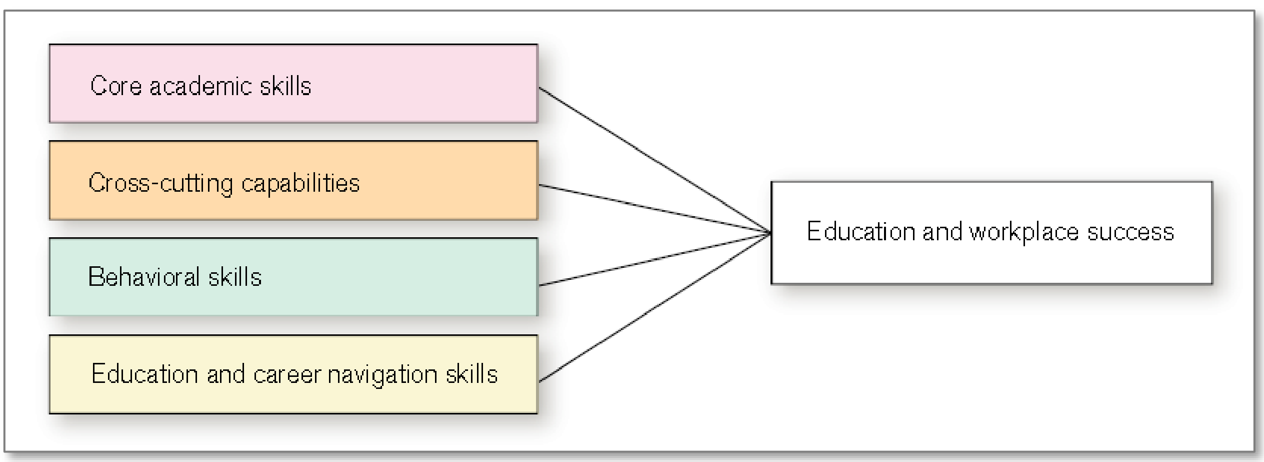

Figure 4. The four pillars of ACT's Holistic Framework. *Source: ACT, Inc.*

The second pillar, cross-cutting capabilities (*see Figure 4*), forms the basis of this capstone research study. Cross-cutting capabilities (CCC) are described as "the general knowledge and skills necessary to perform essential tasks across academic content areas" (*Ibid.*, p. vi); they speak to "the demand and need for a broader range of cognitive skills to adequately prepare students and adults for high-demand jobs" (*Ibid.*, p. 19).

The CCC pillar includes a sub-category called Technology and Information Literacy (TIL), which is essentially synonymous with the ICT skills described by the Partnership for 21st Century Skills. The latent construct that underpins the Technology and Information Literacy framework is a collection of skills organized under three strands: "Foundations of Technology," "Acquisition of Technology" and "Application of Technology" *(see Figure 5)*. These broad

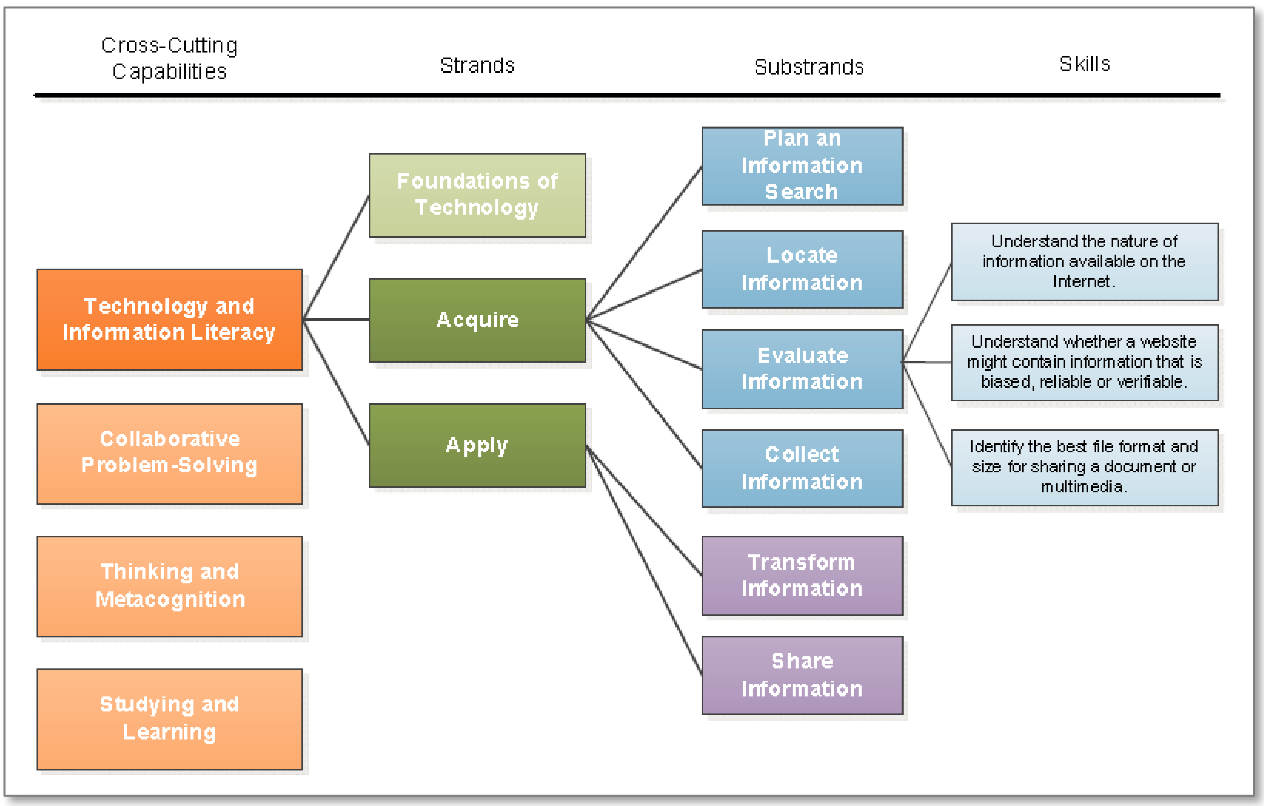

Figure 5. Illustration of the cross-cutting capabilities framework, organized from broad categories to specific skills. *Source: ACT, Inc.*

categories are additive insofar as the second and third strands rely on one's abilities in the first; foundational skills that workers may have, e.g. keyboarding skills, familiarity with computer hardware and operating systems, and a general understanding of ethics on the Internet will support their ability to "research and acquire information using technology" and to "apply and create artifacts using technology" in a broad array of on-the-job tasks (Camara, O'Connor, Mattern, & Hanson, 2015).

Within the second and third strands are six unique substrands *(third column above)*, delineating the specific means by which workers may acquire and apply their foundational skills.[1] These six substrands are the focus of the current study.[2] Each substrand includes specific scaled benchmark items *(examples in the fourth column above)* that were developed and validated by international research consortia during their studies and adapted for use in this capstone project. This is the basis for the first major data collected through this pilot study: establishing the likely ICT skill level required for each person's job based on their responses to the items included in the survey.

2.3 Official Data on Occupational Knowledge, Skills and Abilities

Having discussed the implications of the College- and Career-Readiness movement and the definition of ICT skills for the purposes of this capstone, the last background section will examine the role that official occupational data from the U.S. government plays in advancing an education policy agenda that includes ICT skills.

Advances in technology continue to shape the nature of work. The American labor market has gradually transitioned from one that emphasized rule-based jobs (e.g., clerical work; sales; food and personal services; blue collar industrial, construction and manufacturing occupations; mining and forestry, etc.) to one that now emphasizes the translatable skills needed to complete more complex and multidisciplinary tasks on-the-job (Autor, Katz, & Kearney, 2008; Katz & Margo, 2013; Carnevale, Smith, & Strohl, 2013). Accordingly, many occupations now require the application of critical thinking, information processing and problem-solving skills while performing work that isn't specifically technical in nature (Camara, O'Connor,

[1] The full construct for each of the six strands (which cannot be shared in this paper due to a non-disclosure agreement) includes a benchmark and performance sample statements under each of the four ICT skill levels, along with survey item statements developed from these benchmarks and samples. The fourth column in Figure 5 represents three example benchmarks, which are associated with levels 1, 3 and 4 of the Evaluate substrand.
[2] ACT already completed prior research into the first strand, "Foundations of Technology," in early 2015.

Mattern, & Hanson, 2015). ICTs, as discussed in the previous section, fit neatly into some educational frameworks that emphasize a balance of cognitive and non-cognitive skills. Many of the research studies cited above also express the relevance of ICT skills for workplace success.

Since ICTs are a skill that reflects in a workers' ability to communicate *about* information *using* technology, ICTs function across the spectrum of occupation-specific knowledge that employees might be called upon to demonstrate as part of their work responsibilities (Binkley, et al., 2015; Warschauer, 2003; ECDL Foundation, 2015; Camara, O'Connor, Mattern, & Hanson, 2015). Many career opportunities now occur in "technology-rich environments" (Pellizzari & Fichen, 2013) and occupational knowledge is increasingly mediated by technology (National Center for Education Statistics, 2013). Consequently, a more agile and modern workforce must develop the ability to navigate these environments. Workers must enlist their ICT skills to translate and share knowledge across disciplines as they interact with coworkers from different areas of their industry, with customers, and as they themselves move through their careers.

ACT's focus on "high-demand jobs" like engineering, nursing, accounting, paralegal work and so on, stems from its proprietary research (as well as several public studies) into current high school students' preferred career paths and interest in using technology in the workplace. This focus also represents ACT's recognition that ICT skills can increasingly be discussed in terms of job zones or occupational clusters used to designate certain career paths by the U.S. government, such as through its O*NET resource.

Both the U.S. Department of Labor (through the Bureau of Labor Statistics) and the U.S. Census maintain extensive web-based databases and conduct regular surveys of the American workforce. The Department of Labor funds the National O*NET Consortium, whose website “specifies the full set of occupational competencies required for success in particular occupations and related clusters of similar careers” (Carnevale, Smith, & Strohl, 2013). Among this full set of data are extensive documentation about the “knowledge, skills and abilities” required for each of the 1,100+ distinct occupations organized under the BLS “Standard Occupational Classification” (SOC). These can be found in the Occupational Outlook Handbook (U.S. Department of Labor, 2015) for each job class, each of which include detailed information to help people who are about to enter the workforce or are looking to make a change as they navigate their career opportunities. This also includes data about everything from the sectors experiencing the most growth to those that require higher and lower amounts of technical expertise. Finally, as introduced earlier, BLS has applied a specific Job Zone code (on a scale of 1 to 5) to each job, indicating a definitive level of educational training, related experience and on-the-job training that one should reasonably have to enter that occupation.

The U.S. Census, meanwhile, conducts an annual survey called the Current Population Survey. This instrument asks questions about the real-world knowledge, skills and abilities demanded of workers across all 23 O*NET-identified job sectors, which is then used by BLS to continually update its records and the information contained on its Occupational Outlook Handbook website (U.S. Department of Labor, 2015). Together, this publicly-available information is critical in understanding the role that ICT skills now play in different jobs and occupations. It is also an essential tool for comparison against the pilot data collected for this capstone, and it could also pave the way for testing a more robust research question than is being asked presently—about the extent to which these BLS and U.S. Census occupational data align with the real-world requirements of specific jobs, and whether these tools offer a reliable and accurate service for the U.S. labor force to match its skills with prospective employers.

ICTs are merely one piece of this larger puzzle. The Center for Education and the Workplace (2013) draws the distinction between knowledge, skills and abilities, saying that skills "promote further learning" and include "content, processing and problem solving" e.g. active listening, speaking and writing; active learning, critical thinking, learning strategies and monitoring; and identifying the nature of complex problems and exploring the "related information required to develop and evaluate options and implement solutions" to these problems. The CEW also states that skills are more easily transferred between occupations than knowledge, which is often specifically tied to one job family or zone.

ACT has a similar view of ICT skills as a broadly applicable cognitive ability that are "central to daily tasks in a majority of occupations" and translatable as people move to new career opportunities (Camara, O'Connor, Mattern, & Hanson, 2015). According to ACT's Holistic Framework, this qualifies ICTs as a "cross-cutting capability," one that provides a useful foundation for finding information and communicating it with coworkers, supervisors and customers. It is essential because "as technology becomes more integrated into organizations, collaboration and group problem-solving processes are becoming more increasingly virtual" (*Ibid.)*. Thus, workers across the upper three job zones defined by the U.S. Department of Labor—zones 3 through 5, even if some of those jobs represent occupations without a clear technological component—may find that their job responsibilities include the ability to engage in complex tasks and to communicate *about* information while *using* technology (National Center for O*NET Development, 2016). These are the specific job zones of interest to ACT, which has identified several job families as strategically value for analysis: accountants, engineers, the military, nurses and paralegals.

Of course, across the spectrum of occupations held by American workers, some may require the acquisition and application of ICT skills and others definitely do not—especially those in job zones 1 and 2 (U.S. Department of Labor, 2015; National Center for O*NET Development, 2016). Consequently, the O*NET occupational categories to which workers' jobs belong are an essential variable that appears on the survey instrument created for this capstone. Paired with the ICT skill level that a worker believes is actually required of her or his job—which can be tied back to the job zone—this forms the two major variables that comprise this capstone's analysis.

3 DATA AND METHODOLOGY

This section will discuss: (1) the survey design used to create the data source for the analysis that follows; (2) the specific variables sought for the purposes of analysis; (3) the sampling methods and descriptive statistics about the sample obtained; and (4) possible sample selection bias and limitations to the analysis.

3.1 Data Source and Survey Design

During the first two weeks of March 2016, an online survey—developed in Qualtrics—was distributed through the crowdsourcing research site Amazon Mechanical Turk. The response rate was 100%, owing to the MTurk platform's "payment for work performed" structure.[3] The number of observations recorded, after discarding approximately one dozen incomplete or invalid responses, was $n = 482$.

This survey *(see Appendix A for the entire survey or click here to access it electronically)* asks content-oriented questions about the extent of the likelihood that the respondent's current or

[3] Per ACT's standing policy and academic research best practices, the MTurk Assignment's compensation rate was targeted at minimum wage. Initial payments of $3.65 per response were made to the first 100 responses, based on pre-testing determinations of an approximately 30-minute response time. This was lowered to $2.80 for the rest of the collection when it was determined that the average response time was below 20 minutes.

recent full-time job required the listed ICT skills. The ICT items are based on the "Acquire" and "Apply" strands in the Cross-Cutting Capabilities section of the Holistic Framework (*see Figure 5, column 2*) using validated sample statements from the underlying construct to support the scale. Respondents see the thirty-five ICT-related items across six pages, one for each substrand in the CCC framework (e.g., "Plan," "Locate," "Evaluate," and so on). Between five and seven items are listed on each page, in randomized order, with one attention check item present on the third substrand's page. The respondents are instructed to answer the prompt, "How likely is your occupation to require this skill?"[4] Response values are comprised of a four-level Likert scale: "Extremely unlikely"; "Somewhat unlikely"; "Somewhat likely"; and "Extremely likely."[5]

Accompanying these items are a series of respondent characteristic and demographic questions intended to provide for the possibility of additional correlations during the analysis stage: age, gender, education level, annual income (in their non-MTurk occupation) and ethnicity/race. The respondent's specific occupation is also collected in the survey, aligned with the Bureau of Labor Statistics/O*NET "Standard Occupation Classification" codes (version 20.2) and making use of the Qualtrics drill-down capability to aid in selection of the appropriate job industry, category, sub-category and class. An additional question asking respondents to supply three specific tasks they complete on-the-job is required in order to confirm the validity of each occupational response.[6]

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[4] The instructions and question logic earlier in the survey further guide respondents to confirm that they are at least 18 years old, a U.S. resident, employed or recently employed in a non-MTurk job consisting of at least 25 hours of work per week, and asking them to consider *only* their non-MTurk occupation when answering.

[5] Only four values were available for this question, omitting the middle ("non-opinion") option, because the ICT questions were adapted from international frameworks that diagram the construct as having four distinct levels (1-4). Thus, the scores obtained from these items will align with the levels of Technology and Information Literacy ability in correspondence to these frameworks and without the need for standardization.

[6] Additional sections asking about the respondent's perceptions about job satisfaction, engagement and burnout were also included in the survey, and an additional question about the extent to which each respondent's non-MTurk job is performed remotely was added at the last minute. These items were analyzed by ACT, it are not part of the research question covered in this capstone project.

3.2 Variables and Analysis

The research question is:

- "What is the relationship between the information and communication technology (ICT) skills actually required of workers' jobs and the different job families these workers inhabit?"

Two critical categories of variable are needed from the dataset in order to conduct the intended analysis. They are summarized in the Table 1 below:

Occupational Variables	ICT Skill Variables
O*NET SOC job industry	Plan an information search
O*NET SOC job category	Locate information using technology
O*NET SOC job sub-category	Evaluate information accessed using technology
O*NET SOC job classification	Collect information using technology
O*NET Job family / job zone	Transform information using technology
Current job title (for validation purposes)	Share information using technology

Table 1. Dependent and independent variables from the Qualtrics survey used for research question analysis.

The instrument is designed to identify the technology-rich and technology–poor occupations by SOC code, which can be referred back to specific O*NET job zone during analysis. Neither of the two above columns represents a dependent or independent variable, owing to the analytical plan—the purpose of collecting these variables is to run descriptive statistics, correlations, a one-way ANOVA to determine the extent to which the mean ICT score(s) change based on different groups, and a two-way ANOVA to determine the extent and direction of the relationship between ICT skills and job zones.

3.3 Sampling Methods and Description of Sample

Using the Amazon Mechanical Turk crowdsourcing platform, a "worker assignment" was created with a link to the Qualtrics survey and specific instructions about how to complete it. MTurk allows "requesters" to connect with available "workers" who will complete a survey, assignment or task that specifically requires human input in order to be valid. Response rate was 100%, although approximately one dozen responses were deemed invalid due to an inadequate length of time taken to complete the survey.

MTurk allows for a great deal of sampling customization. Among the qualification filters used for this survey were: (i) only workers from the United States could accept the assignment; (ii) only workers with at least 500 approved HITs[7] were permitted; and (iii) only workers with a 95% approval rate could accept. Additionally, a code word was added to the final page of the survey to allow workers to request payment at the conclusion of the survey; respondents who failed to provide the code word, failed the attention check question, or completed the survey in less than 10 minutes were rejected.

An initial pilot survey was launched with a maximum cap of $n = 50$ to start, in order to identify any item issues. A second run of $n = 50$ was started 24 hours later, during a different part of the day. A third run of $n = 200$ was started two days later. At the end of this collection, an initial analysis of the occupation clusters represented by these first 300 responses was performed in order to ensure that the sample had balance in accordance with ACT's research interest—to achieve a valid and sufficient sample of certain in-demand occupations that the U.S. Department

[7] Human Input Tasks, or HITs, are another name for the assignment designated to each worker.

of Labor also considers “technology-rich” and attainable for workers with a reasonable amount of ICT skills i.e., jobs in zones 3 and 4 (*see Figure 6 for the breakdown of respondents by job family at* n = *200*). To encourage more participants from these specific occupations, for the final

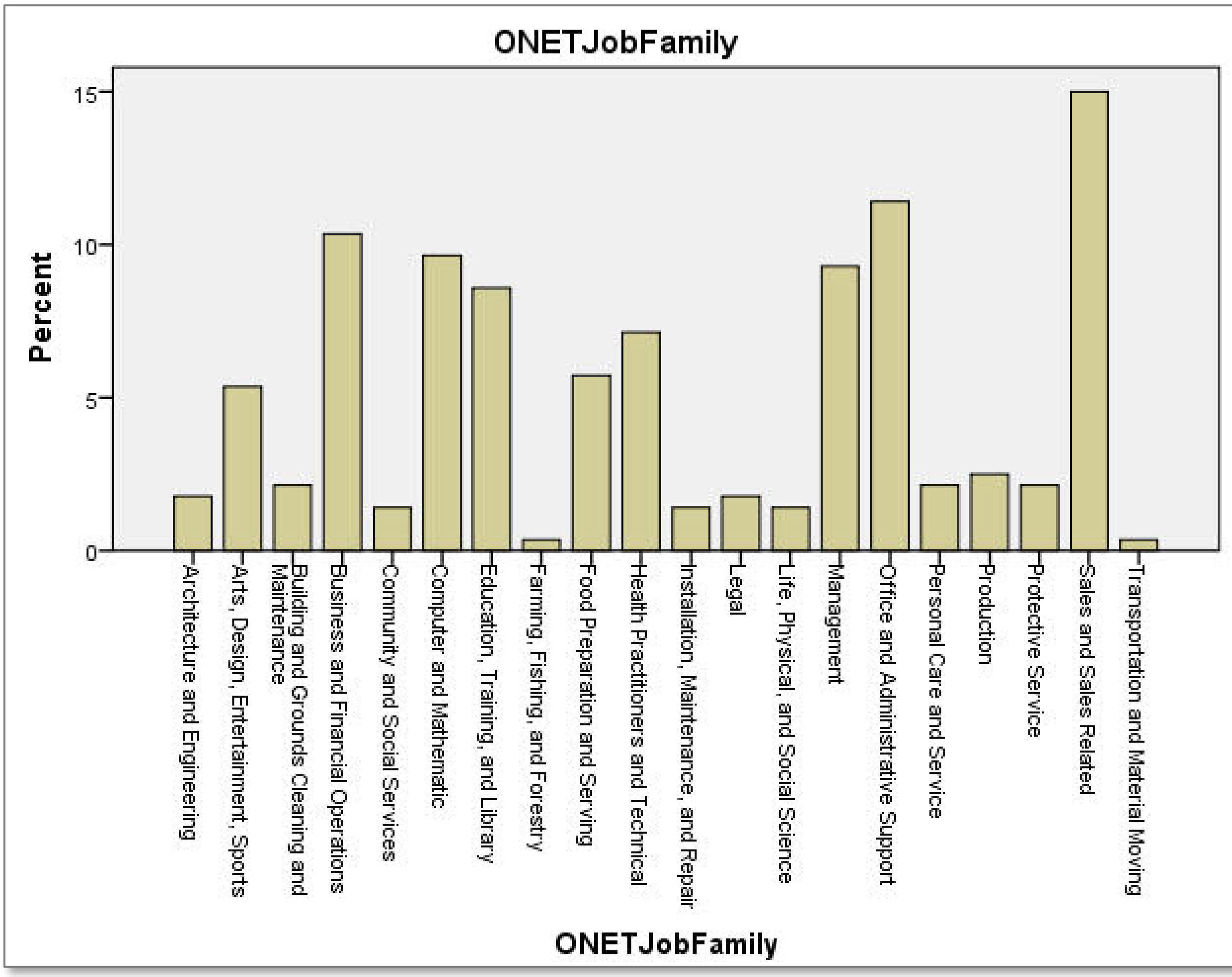

Figure 6. Percentage of respondents at n = 200 by O*NET Job Family (industry).

stage of the collection a decision was made to over-sample MTurk workers from five specific occupation clusters: accountants, engineers, nurses, paralegals and military jobs (capped at an additional n = 40 per classification). The total sample achieved through this two-stage sample selection process was n = 482.

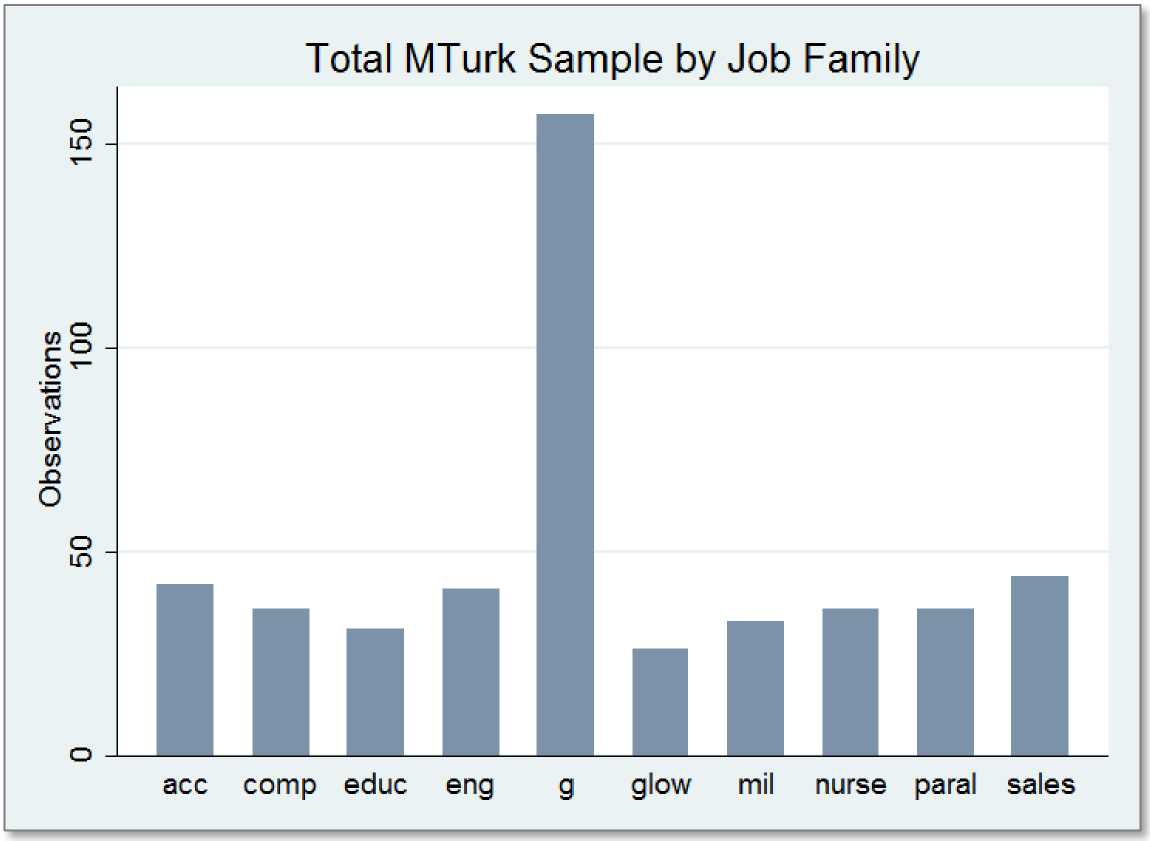

Figure 7. Total observations at the end of data collection by job family (n = 482).

At the end of the collection period, all observations were sorted by job family (*see Figure 7*). Table 2 (*below*) shows the demographic breakdown of the sample.

	Avg. Age	Avg. Education Level	% Male	TOTAL
White	33.8	4.36	61%	**420** (87%)
Hispanic	29.9	4.38	75%	**40** (8%)
Asian	33.0	5.03	67%	**36** (7%)
Black	32.1	4.53	61%	**30** (6%)
Amer. Indian	39.3	4.25	50%	**4** (1%)
Pacific Islander	30	6.00	100%	**1** (< 1%)
TOTAL	**33.6**	**4.42**	**61%**	**531**

Table 2. Total observation demographics at the end of data collection (n = 482).

Note: Numbers in the TOTAL column do not add to 482/100% because some respondents identify from two races.

3.4 Sample Selection Bias

Although the original goal of the survey instrument was to obtain a representative sample of the entire U.S. working population (if possible), given that the recruitment method for this survey was exclusively conducted via Amazon MTurk, there is the inherent possibility of bias in the sample if used for this purpose. Most notable is the potential ethnic/racial skewedness of a population of workers with access to a computer and the Internet, or the potential age skewedness that may accompany one's familiarity with the so-called online "gig economy."

The demographics identified on the previous page indicate that skewness is a legitimate concern, with 87% identifying as white and 61% of the sample identifying as male—for higher in each category than the U.S. working population as a whole. Additionally, the average education level of 4.42 falls roughly halfway between the survey responses for "two-year college degree" and "four-year college degree," indicating that the sample has a slightly higher education level than the rest of the U.S. population. Finally, the over-sampling of specific occupation clusters in job zones 3 and 4 could require analytical weights to make more generalizable. Hence, this sample may more appropriately be stated as representing a population of the employable, technically-savvy workers who are aware of MTurk. As a pilot study and a "proof of concept" about the items on this study, this may be adequate; a larger study may require different sampling methods in order to ensure proper and sufficient balance.

4 FINDINGS

The analysis of 482 responses obtained from the online survey was completed in March 2016. Both descriptive and inferential statistics are derived from the sample data using SPSS and Stata software packages. A summary of statistical techniques and key results follows:

4.1 Descriptive Statistics and Exploratory Analysis

4.1.1 ICT Skills by Substrand (Domain)

Means and standard deviations for the 35 ICT skill items (on a scale of 1-4) are calculated across all observations and in both directions. As a reminder, these items ask about a subset of ICT skills with applicability to many different jobs, not specifically technical ones. These skills could involve a workflow such as: (i) navigating a search engine to find information; (ii) evaluating this information for reliability, validity and relevance; (iii) creating a word processing or presentation document using computer software to communicate about the information found on the web search; (iv) using hyperlinks or images in these documents; and (v) attaching these files to an email. These are skills that could be used by many different workers in both technical and non-technical occupational clusters and in all job zones regardless of educational level. Higher scores indicate a higher likelihood that these skills would be needed.

The ICT skill scores are first grouped together by each individual respondent row to create a separate average for each of the six substrands (e.g., “Plan,” “Locate,” “Evaluate,” etc.). Then a composite score across the six substrands is computed, representing each individual observation’s total ICT skill level across all 35 items for the underlying ICT skill construct. These are used to determine reliability of the individual items, which will be discussed in section 4.1.3 below. Next, means and standard deviations are calculated for each of the six substrands across all 482 observations, to be used in a correlation analysis with the respondent’s occupation category and, ultimately, with their corresponding job zone.

ICT substrand (domain)	Mean ICT score	Std. Dev. ICT score
Plan an information search	2.96	0.78
Locate information	3.07	0.77
Evaluate information	2.75	0.82
Collect information	2.95	0.80
Transform information	2.63	0.85
Share information	2.98	0.80
TOTAL	**2.88 (out of 4)**	**0.72**

Table 3. Total ICT skills by substrand and overall, measured by mean and standard deviation.

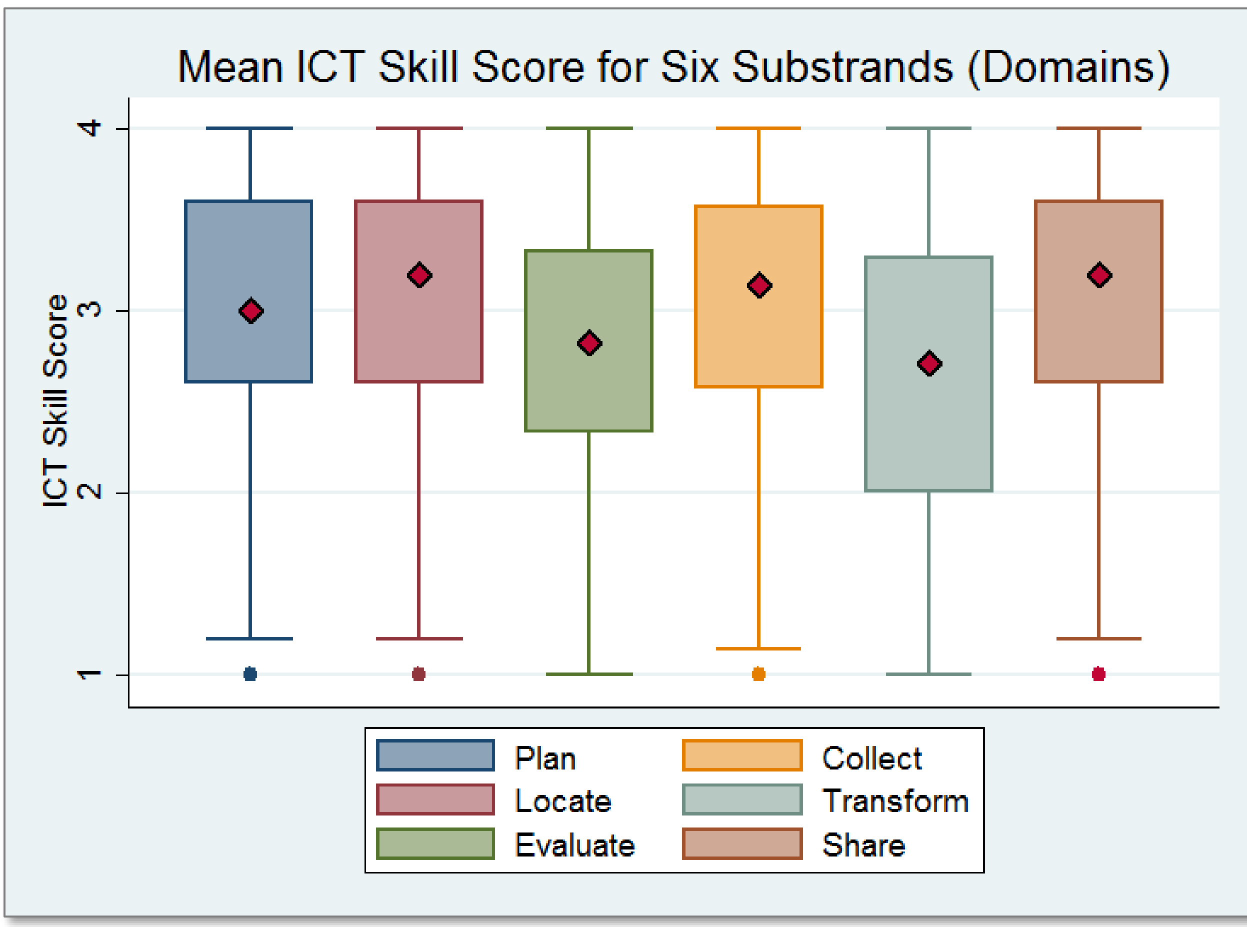

Figure 8. Mean ICT skill score by substrand (domain), in a box and whisker plot.

Across all six substrands, the means and standard deviations reflect that respondents generally feel that their job requires a high degree of capability with ICT skills, and that their employers (or employers like them) would expect any newly-hired employee without any prior on-the-job training to demonstrate these abilities. A composite mean score of 2.88 (across all six substrands) indicates a level of proficiency above entry-level occupational standards specified by the Department of Labor for most job zones, further suggesting the importance of these skills among employers.

4.1.2 Reliability of the ICT statistics

Based on item-total correlation analysis and Cronbach's alpha, the tested reliability of the ICT skills statistics are promising *(see Table 4)*. These two tests are exploratory techniques used to examine the correlation between the mean of individual items and the overall composite score. It is useful for determining if certain items are inappropriate or that vary more than expected, as indicated by a lower coefficient score in the range from 0 to 1. For this dataset, most alpha scores for the individual ICT skill substrands ("Plan," "Locate," "Evaluate," etc.) are well over the standard statistical benchmark of 0.8, and the composite score is even higher.

ICT Substrand	Cronbach's Alpha
Locate	0.871
Collect	0.896
Share	0.853

Table 4. Example reliability scores from three of the six ICT substrands.

However, a very few specific items from the survey dragged down the reliability of the overall statistic. There were just three items across all six substrands with a corrected item-total correlation between below 0.6 *(see Table 5)*. Since these items are part of the overarching scale that represents the latent ICT skill construct, adjustments to these items could prove beneficial for future iterations of the survey. It is likely that there was simply some confusion by respondents over how to answer the prompt, suggesting that simple rewording could be enough; although replacement with another item from the lengthy list of sample statements tied to the ICT benchmarks could also improve the instrument.

ICT Substrand	Item Description	Item-Total Correlation
Locate	"Explore a website to find an answer to a specific question."	0.503
Collect	"Collect information using an audio or video recording."	0.523
Share	"Collaborate with others using social media."	0.412

Table 5. The three weak items, which appear in the same three ICT substrands shown in Table 4.

4.1.3 Exploratory Factor Analysis

To test whether the composite ICT skill score has a strong correlation with each of the individual substrand scores, an exploratory factor analysis (EFA) is performed to see whether the model "hangs together." This technique verifies the underlying structure of all the items in a dataset to determine which, if any, variables are responsible for the largest amount of variance among responses and whether all items need to be considered separately or can be aggregated together. Items with a higher "Eigenvalue" should remain distinct, but any that fall below a score of 1 are considered "scree" (as in, the rocky detritus one finds at the end of a glacial moraine) and are not contributing substantially to the model representing the construct that is being tested. The early appearance of a bend, or "elbow," in the graph usually indicates that items can be consolidated (Moutinho & Hutcheson, 2011; Suhr, 2006).

In the case of this capstone study, this could mean that the entirety of the Acquire and Apply ICT skills survey forms a complete construct, as opposed to six individual constructs—

represented by the six distinct substrands. If that is the case, the single composite ICT skill score (with a mean of 2.88) could be used in the remaining analytical tests, rather than having to test each of the six substrands against each job zone.

Indeed, the scree plot *(see Figure 9 below)* shows that each of the 35 individual ICT items load together on one factor. This also corresponds to the earlier finding that there were no unique factors creating unreliability in the statistic.

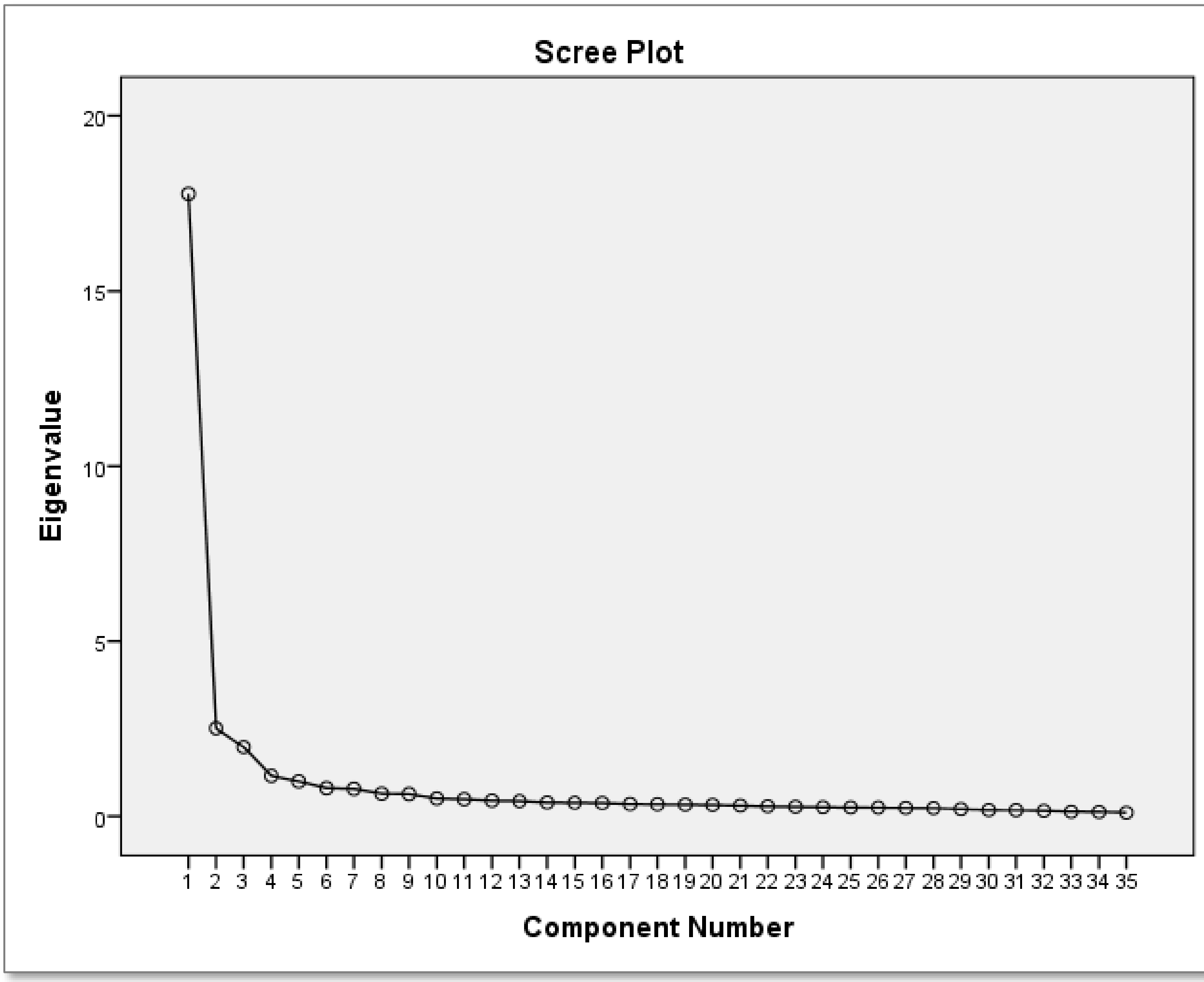

Figure 9. Screen plot with Eigenvalues showing that the composite ICT score is best expressed as a single variable.

This graph confirms that the ICT skills should be measured using a single, combined ICT variable as opposed to representing them as separate skills derived from separate constructs. A confirmatory factor analysis is the best analytical tool to confirm that the ICT value is best represented as a single, total score; but this requires a well-defined model *a priori* as well as Structural Equation Modeling (SEM) to complete (Suhr, 2006). CFA is beyond the scope of this pilot study's analysis. The bottom line is that all six domains appear to share a common conceptual meaning in defining a level of ICT skills required by specific occupations.

4.1.4 ICT Skills by Job Zone

Armed with the information from the exploratory factor analysis, an analysis of the single composite ICT skill score in terms of each respondent's industry code (11-59 from O*NET/Bureau of Labor Statistics) and ultimately the corresponding job zone (1 to 5) for that occupation is performed. First, the industry code and job title specified by each respondent is used to generate a "job family" variable. Table 6 and Figure 10 summarize these data.

Job Family	Mean	Standard Deviation	Frequency
Accountants*	3.05	0.48	42
Computer Tech	3.31	0.40	36
Education	3.17	0.38	31
Engineers*	3.11	0.52	41
Military*	2.79	0.73	33
Nurses*	2.86	0.54	36
Paralegals*	3.17	0.60	36
Sales	2.22	0.77	44
General	2.92	0.65	157
General (low)†	1.83	0.93	26
TOTAL	**2.88**	**0.72**	**482**

Table 6. Composite ICT skills by job family, measured by mean and standard deviation.

Note: An asterisk (*) indicates the pre-selected and over-sampled job family categories.
A dagger (†) indicates the category created ex post facto *to avoid skewness in the General category.*

The five job families chosen for this analysis are in keeping with ACT's research goals, to understand the real-world ICT requirements for jobs that generally fall in job zones 3 and 4. These occupations are identified as "in-demand" by ACT and the analysis confirms that they do carry a slight premium for ICT skills. Compared to the composite mean of 2.88, the higher mean scores for accountants (3.05), engineers (3.11) and paralegals (3.17)—jobs already identified as job zone 3 or 4 on O*NET—suggest a correlation between the ICT skills actually required for these jobs and the higher technical skill level requirements published on O*NET.

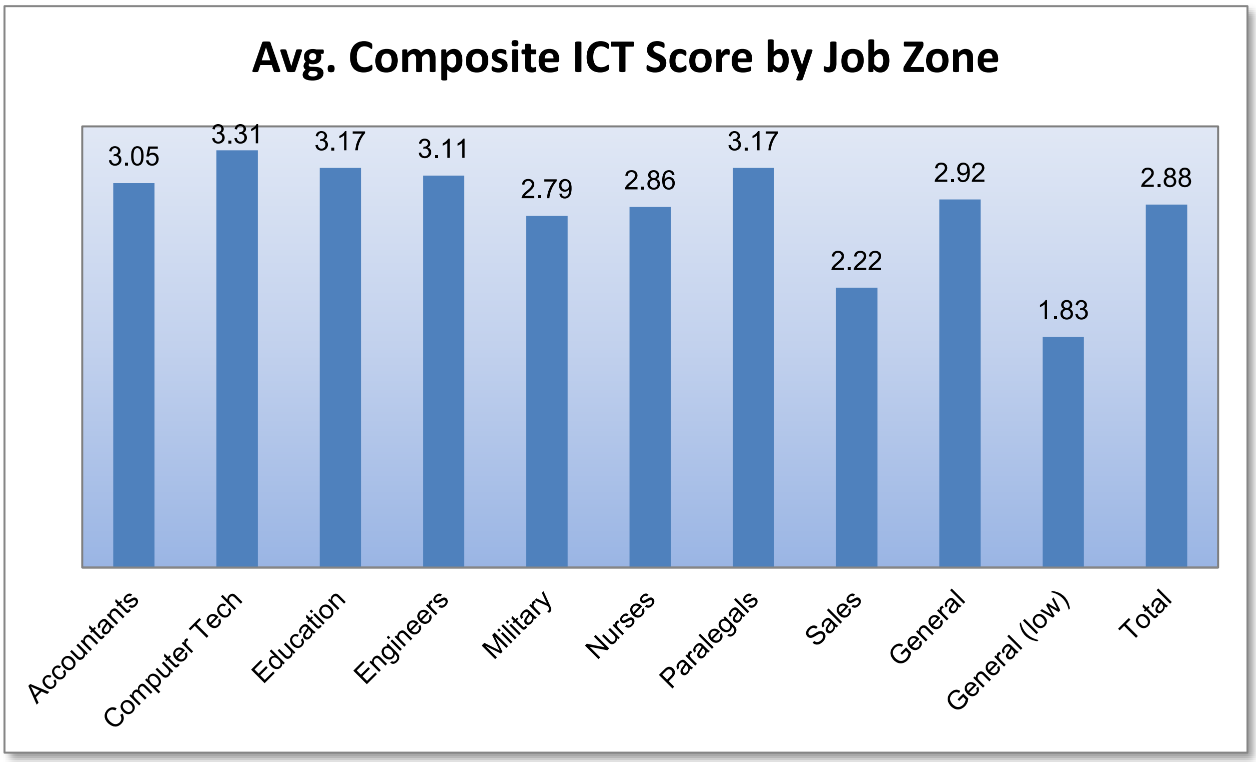

Figure 10. Composite ICT skills by job family.

While military jobs (2.79) and nurses (2.86) are below the composite average, this could relate to the high variability in jobs and tasks required by those in the armed forces or in hospitals and allied health careers; the high variance would seem to support this conclusion. It also aligns with what O*NET has published about these high-growth occupational clusters, that there are a large number of *both* technical and non-technical jobs increasingly becoming available in both fields. It may also reveal that non-technical jobs in the military and healthcare are at a further remove from the kind of ICT skills discussed in this paper, perhaps owing to the infrequency with which those jobs allow workers to sit at a desk and use a computer. A higher sample size than the one in this capstone study would be needed to confirm this hypothesis.

Investigating different job categories beyond the "in-demand" jobs specified by ACT—by further breaking down the 294 observations left in the General category after pulling out the original five "in-demand" job families of accountants, engineers, military, nurses and paralegals—it also appears that there are several more distinct clusters of jobs that require higher or lower ICT skills than others. These additional job families (computer tech-related jobs, educators and sales) achieved sufficient *n* to be broken out and examined on their own. However, these three job families have quite a degree of variability in the job titles and tasks performed. For example, some educators are middle and high school tutors, while others are college professors—jobs that require very different levels of preparation and have different job zones according to O*NET. These categories may have less probative value for analysis as a result, although their standard deviations are not very high.

There are also $n = 26$ observations that do not fit into one of the pre-selected and over-sampled job families, but that pull down the average in the "General" category considerably. A "General (low)" category is offered to delineate these lowest-skill jobs from job zone 1, consisting of occupations such as installation, production, buildings & grounds cleaning and maintenance, personal care and service, and food preparation.

4.2 Inferential Statistics and Measures of Association

Using the composite ICT scores from each job family, measured in the last section, a one-way ANOVA correlation analysis is performed. This test essentially verifies the statistical significance of the different ICT scores between the job family subgroups that was discussed in the last section. In other words, it confirms that there were enough observations collected to substantiate the claim that some job families require more on-the-job ICT skills job than others. Figure 11 presents the overall strength of relationship between the ten job families (F-value = 18.14; p-value = 0.000).

famdrew	Summary of ict Mean	Std. Dev.	Freq.
acc	3.0497619	.47820542	42
comp	3.3077778	.4019674	36
educ	3.1677419	.38415022	31
eng	3.115122	.52067324	41
g	2.9178344	.64704191	157
glow	1.8369231	.9251671	26
mil	2.7936363	.73180353	33
nurse	2.8647222	.54868924	36
paral	3.1680556	.60870739	36
sales	2.2247727	.76676454	44
Total	2.8759544	.71544298	482

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	63.2683847	9	7.02982053	18.14	0.0000
Within groups	182.935628	472	.387575484		
Total	246.204013	481	.511858655		

Bartlett's test for equal variances: chi2(9) = 45.3760 Prob>chi2 = 0.000

Figure 11. One-way ANOVA results for composite ICT skill score by job family.

However, this finding is limited by the fact that correlation does not imply causation; there are other alternate theories and factors that would need to be controlled for in further analysis, and confirmed by a regression to check the hypothetical model. This is beyond the scope of this pilot capstone study.

Next, instead of using the job families ("accountants," "engineers," etc.), each individual's actual job title is analyzed alongside the education level they specified. This is used to arrive at the likely job zone to which that respondent belongs, which tends to deviate only slightly from the likely job zone to which each family belongs according to O*NET. This analysis was required because some unique job titles convey a different meaning than the job categories and sub-categories selected by the respondent. For example: almost every respondent clustered in the "accountant" job family belongs in job zone 4, but there are some who indicated that they are a Certified Public Accountant and had obtained a Master's degree; these were moved to job zone 5.

Given the continuous, non-integer nature of the composite ICT skill score variable and the independence of observations in the ordinal job zone variable, as well as the lack of any outliers in either variable, a two-way ANOVA is performed. Figure 12 demonstrates that the interaction between one's job zone and the level of ICT skill that they would expect from a new hire in their current job has a statistically significant positive correlation (F-score = 17.66, two-tailed p = 0.000 with four degrees of freedom).

	Number of obs =	482	R-squared =	0.1290	
	Root MSE =	.670499	Adj R-squared =	0.1217	

Source	Partial SS	df	MS	F	Prob>F
Model	31.759602	4	7.9399004	17.66	0.0000
zone	31.759602	4	7.9399004	17.66	0.0000
Residual	214.44441	477	.449569		
Total	246.20401	481	.51185866		

Figure 12. Two-way ANOVA results for composite ICT skill score by job zone.

The two-way ANOVA is more easily visualized in the dot plot seen in Figure 13, which includes a trendline showing the positive correlation from job zone 1 to job zone 5. As the job zone of the respondent's current job increases, their perception of the ICT skill level expected by their employer consequently increases.

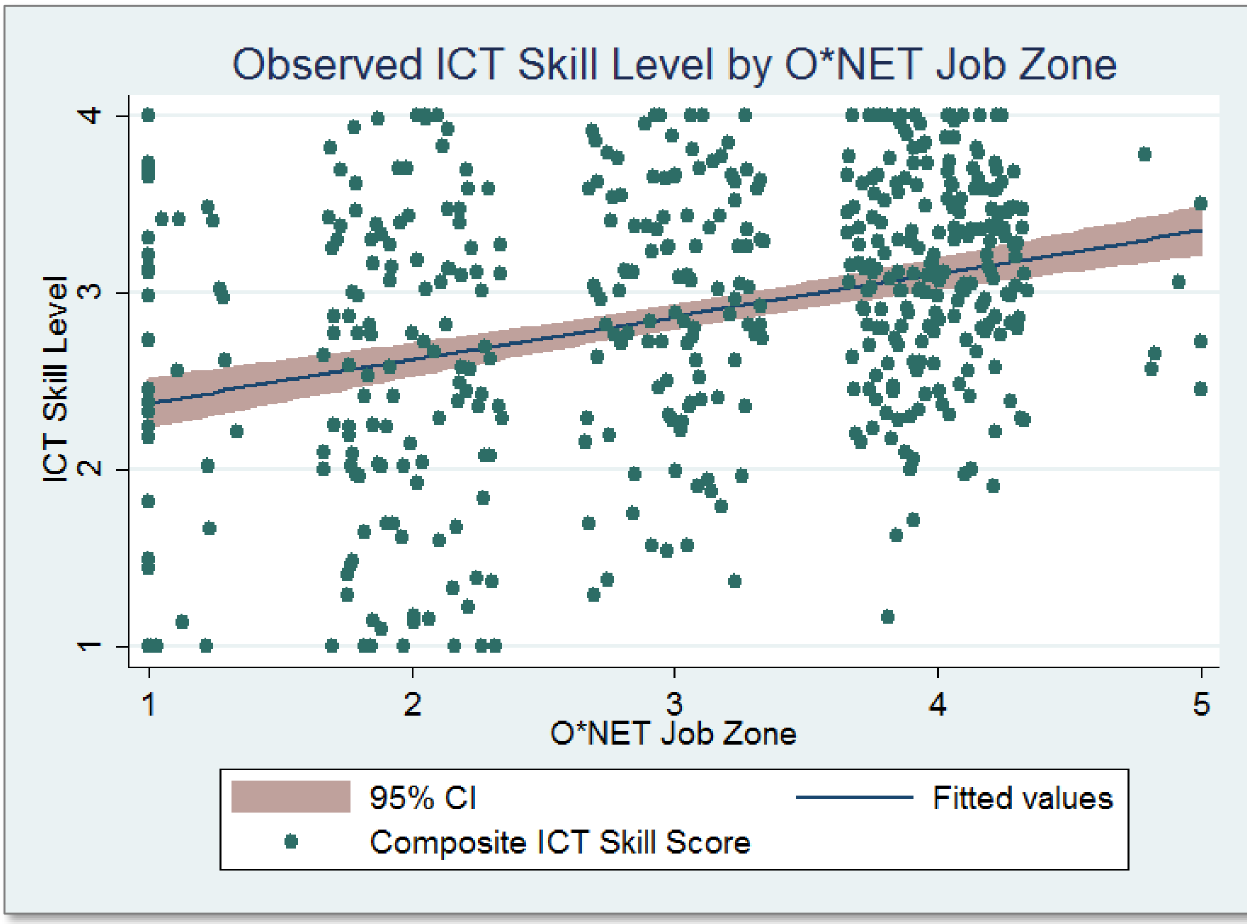

Figure 13. Dot plot with confidence interval and trendline for composite ICT skill score by job zone.

4.3 Limitations of Generalizability

There are several limitations to the statistical inference that we can draw from these results, largely owing to the size of the sample and the nature of its collection using Amazon MTurk. First, MTurk is not fully representative of the U.S. labor force writ large. Although responses from all five O*NET job zones are available in the dataset, several known lower-technology jobs were under-represented. Given the client's focus on specific "in-demand" occupations, this may not represent a significant limitation to generalizability of these data; however, for the purposes of a larger public policy initiative, such as educational reform or workforce development strategies, it may present problems. Regardless, since this is a pilot study, a larger dataset with more robust sampling methods could reveal different trends and account for alternate explanations for the relationship between the composite ICT skill variable and job zone.

Additionally, correlations—which are the basis of the exploratory factor analysis and any conclusions that we draw thus far—are only used to describe relationships; it is therefore unwise to draw causal inference from correlations alone (Moutinho & Hutcheson, 2011), without further exploring the underlying model upon which the ICT skills and engagement-burnout constructs are based.

5 DISCUSSION AND POLICY RECOMMENDATIONS

The results from this capstone project suggest one initial takeaway: that information and communication technologies are a vital skill for the U.S. workforce and that the impact of ICTs—and perhaps the impact of formative curriculum to train people in these skills—should be measured and evaluated. The client for this capstone, ACT, is eager to translate these data into insights that will inform both their internal assessment designs as well as social research on a larger scale. Each effort may help individuals and organizations enhance their success in college and career, which aligns with ACT's mission.

After completing this pilot version of this survey of ICT skills in the workforce, a good first step has been made in answering the research question proposed earlier:

- "What is the relationship between the information and communication technology (ICT) skills actually required of workers' jobs and the different job zones that these workers inhabit?"

Since the ICT theories from the international consortia form the basis of the cross-cutting capabilities language in ACT's Holistic Framework, and ACT's interest is in empowering individuals and organizations to enhance workforce skills, this capstone satisfies the essential administrative goal determined at the outset of the student-client relationship: positioning ACT to better facilitate the conversation about ICTs in the United States, especially in view of the critical shortages that may face the U.S. labor market in the next decade. These findings—and subsequent research using this model—may build a pathway for economists, labor leaders and educators as well.

Owing to the size of this survey and analysis, it would be inappropriate to make sweeping, general statements about the relationship between ICT skills and all jobs in the U.S. labor force, or even about the characteristics of specific jobs, e.g. the information and communication technology skills required by aspirational engineers, nurses or paralegals. There is not a sufficient sample size to ensure the validity of any such claims. Instead, the results section above is presented as a first glance at the potential value of these data, and as a potential model for collecting future information about workers in the United States.

However, for the purposes of this capstone, the connections to public policy are more readily apparent and bear mentioning. One recommendation for policy and one recommendation for management follow.

- **Recommendation #1:** United States policymakers should emphasize the addition of cognitive skills, such as ICT skills, to K-12 curricula in a formal, sustainable way.

As ACT and education researchers have learned, cognitive skills such as ICTs, active listening, problem solving and critical thinking are more difficult to teach as a sole content area. Consequently, they are more difficult to measure and benchmark in the same way as academic subjects and core content areas taught using traditional methods.

Nonetheless, every opportunity to build these skills in K-12 students should be taken. Especially because of the evidence from some researchers that earlier educational interventions predict greater levels of success in college and career, promoting the frameworks that inculcate twenty-first century skills will enhance not only the workplace, but the manner in which children attain higher-order skills through the elementary and secondary years—while they are still attending compulsory schools.

The reason for improving K-12 curricula to incorporate ICT skills is clear, and connects back to the policy problem identified in the introduction. Evidence from some researchers already points to the persistence of a "skills gap" between employee abilities and employer requirements. Because so few Americans achieve even an Associate's degree by the time they reach age 25, the skills gap is one of several ways that labor economists describe the premium that a college degree confers on employee wages (Cappelli, 2012; Besson, 2014; Leonhardt, 2014). The education deficit is estimated by the Center on Education and the Workforce at Georgetown University as "300,000 college graduates every year" through 2020 (Carnevale, Smith, & Strohl, 2013).

A widening gap is also one of the possible scenarios that may unfold if students don't emerge from high school with twenty-first century skills. This would signal a potential shortage in the supply of high-skilled U.S. workers relative to rising employer demand over the next decade (Autor, Katz, & Kearney, 2008; Davis, Kimball, & Gould, 2015) as the U.S. adds 9.8 million jobs, 65% of which will require skills that are typically associated with job zones 3, 4 and 5. Some research has also shown that a lack of technical and communication ability is one of the leading reasons why employers and employees experience a mismatch, leading to the high ratio of job openings to unemployed workers identified in Figure 2 (Furlanetto & Groshenny, 2016). The skills gap is significant enough a problem that President Obama alluded to it in his 2016 State of the Union address, declaring: "Real opportunity requires every American to get the education and training they need to land a good-paying job" (The White House, 2016). Obama also spelled out a potential remedy to the skills gap, calling upon under-equipped workers to "retool and retrain" in order to remain competitive in the marketplace and desirable to employers.

But this begs the question: Why not start earlier? Developing curricula to teach basic ICT skills in K-12 schools—to make students *more ready* to enter the workforce or pursue a college degree—and then making sure these curricula are affordable while bolstering their deployment with adequate funding and resources for teachers, is essential. With eventual benefits for the American labor force in mind, skill inventories for schoolchildren could also be developed—which would also serve another of ACT's four primary pillars in the Holistic Framework, the ability and tools to navigate one's career path. Helping children acquire and apply the information and communication skills required by real-world employers is essential; the data from this pilot study will hopefully back up this claim and provide a rationale for further study.

- **Recommendation #2:** Refine and test the O*NET/Bureau of Labor Statistics data, potentially adding more nuance to the current five-zone structure for identifying the educational level, experience and on-the-job training required for different occupations.

This study also points to the need for a potential overhaul of the structured management information system through which occupational data is gathered, stored and disseminated to the public. The current five-zone scale is less informative about the ideal educational level needed by workers for various occupations, given that increasing retention concerns for Americans in college, who complete relevant coursework but fail to earn a credential. This could limit the effectiveness of the information that O*NET hopes to distribute to workers seeking to change careers or students about to graduate from high school or a college or certification program.

Additionally, making these data available on the web is only part of the outreach and engagement that will allow under-skilled Americans an opportunity to gain skills—especially those who are unable to navigate the web adequately. This information is better put to use in the hands of trained practitioners like employment advisors, coordinators at public nonprofits in the labor industry, and—not surprisingly!—education and career counselors in K-12 schools. A more nuanced approach to job zones could make it easier to target efforts and resources, while improving alignment between the information contained on O*NET's website and the real-world ICT skill requirements of American jobs.

Finally, reorganization of O*NET's structure for job zones could allow for a standardized ICT benchmark to be incorporated into the knowledge, skills and abilities required in the 1,100+ jobs they have defined. Despite the international consensus on the importance of ICTs and other cognitive skills in educational curricula and workplace development/training, no similar inquiry into the relationship between American workers and ICT requirements of their job has been performed. This is a growing edge for the information presented on O*NET, as well as being the thread of inquiry that inspired this capstone project. The motivation to develop better management practices will aid those looking to acquire and apply a stronger foundation of information and communication technology skills by making it clear which skills are actually required and expected of employees in specific jobs.

6 CONCLUSION

In essence, this research boils down to an examination of the way that ICT skills, as much if not more than other cognitive skills, are emblematic of the twenty-first century skills that people may seek to attain. At *any* point in the continuum of one's education or career, information and communication technologies hold a special place because they are powerfully integrated into the high-level problem-solving and critical thinking skills that a modernizing workplace will continue to demand. It is critical that people know what types of skills will be required of them, and as early in their aspirational career planning stage as possible. By designing the survey, executing its data collection, assisting with the data analysis and crafting recommendations for educational public policy, it is my hope that I have helped answer questions about these work environment and career navigation issues. Above all, it is the goal of this study that it leads to improved curricular offerings at the earliest stages of compulsory schooling, to help foreclose against poorer college and career outcomes by providing people with baseline technology skills and the opportunity to transition from middle-skill to high-skill occupation zones by "retooling and retraining," to borrow from President Obama's appeal in the 2016 State of the Union address.

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9 APPENDIX A