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Research Report
ETS RR–13-21

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November 2013

ETS Research Report Series

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November 2013

Action Editor: John Sabatini

Reviewers: Ross Markle and Richard Coley

Abstract

To identify the most important competencies for college graduates to succeed in the 21st century workforce, we conducted an analysis of the Occupational Information Network (O*NET) database. O*NET is a large job analysis operated and maintained by the U.S. Department of Labor. We specifically analyzed ratings of the importance of abilities (52 ratings), work styles (16 ratings), skills (35 ratings), and knowledge (33 ratings) to succeed in one's occupation. First, we conducted descriptive analyses. Next, data were split into 2 sets, according to the theoretical structure proposed by the O*NET content model, and principal component analyses (PCAs) were run on each dataset. The PCAs identified 15 components: problem solving, mechanical skills, service orientation, cultural literacy, business literacy, science literacy, civic literacy, information processing, athleticism, visual acuity, fluid intelligence, communication skills, teamwork, achievement/innovation, and attention to detail/near vision. Components were then ranked in importance using the mean component scores over all occupations. A comparison of this ranking with previous 21st century competencies frameworks suggested that 5 competencies stand out as important for most occupations: problem solving (e.g., complex problem solving), fluid intelligence (e.g., category flexibility), teamwork (e.g., cooperation), achievement/innovation (e.g., persistence), and communication skills (e.g., oral expression). Consistent with this conclusion, a correlation of component scores with wages found that 4 of these 5 competencies were strongly related to wages, with the exception being teamwork.

Key words: O*NET, workforce readiness, student learning outcomes, noncognitive skills, job competencies, KSA, job skills

Acknowledgments

This paper was supported by the Research and Development division of ETS. We would like to thank the following individuals for comments and suggestions on an earlier version of this report: Patrick Kyllonen, Richard Coley, Ross Markle, and John Sabatini.

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What are the most essential skills for the 21st century workforce? This question would not be necessary in an ideal world, as educational systems would continually adapt to meet the demands of the economy. There is growing evidence, however, that a mismatch exists between the skills possessed by much of the U.S. workforce and the skills required by U.S. employers. In 2011, a survey of 2,000 U.S. companies revealed that two thirds of these companies reported difficulties finding people qualified to fill some of their open positions (Manyika et al., 2011). Furthermore, some positions had remained open for at least 6 months in 30% of these companies. In addition, a 2006 survey of 431 employers across the United States found that, in terms of their perceived level of readiness for entry-level jobs, 40% rated high school graduates as deficient, 30% rated 2-year college graduates as deficient, and 36% rated 4-year college graduates as deficient (Casner-Lotto & Barrington, 2006). Consistent with these findings, as of March 2012, although over 12 million people were unemployed in the United States, 3.7 million jobs remained open, suggesting that a substantial share of the unemployment rate could be accounted for by a skills mismatch (Bureau of Labor Statistics, 2012).

There is likely not one clear answer to the question of why these skills gaps persist. One possibility, however, is that both students' expectations for what they must learn and schools' expectations for what they must teach have not adapted quickly enough to changes in the economy and the way business is done. One analysis of longitudinal data from 1967 to 1997 found that the United States shifted from a predominately material economy to a predominately information economy during that time (Apte, Karmarkar, & Nath, 2008). In 1967, 54% of the gross national product (GNP) came from the production of material products or services (e.g., automobiles, construction), whereas 46% of GNP came from information products or services (e.g., computers, telecommunications). By 1997, those percentages were 37% and 63%, respectively. During this time, the United States also became more service-oriented. In 1967, whereas 70% of GNP came from services, 83% of GNP came from services in 1997. The most dramatic shift occurred in information services (e.g., telecommunications, education), which accounted for 36% of GNP in 1967 and 56% of GNP in 1997. Presumably, with the continued growth of the Internet and the proliferation of technologies such as smart phones and tablets, the share of GNP accounted for by information services will only continue to grow.

The increased use of computers in the workplace also likely places new emphasis on the skills required of the workforce (Autor, Levy, & Murnane, 2003; Levy & Murnane, 2004;

National Research Council, 2008). For instance, although computers are very good at performing routine tasks, they are not good at performing nonroutine abstract (e.g., creative problem solving) and manual tasks (e.g., driving a car). The implication, of course, is that skills commensurate with completing these nonroutine tasks will become even more important in the future.

The shift to an information and service economy, combined with the computerization of the workplace, required a corresponding shift in the skills required of the workforce. The skills gap described above suggests, however, that education systems have not changed at the same pace as the economy. Note, also, that another implication is that workplaces themselves may have reduced the amount of training they provide to their employees. In response to the perceived lack of attention being placed on re-evaluating the importance of workforce skills, several groups have attempted to develop frameworks identifying the skills most essential for the workforce to possess in the 21st century. These skills often go by the popular buzzword *21st century skills*. Below, we discuss some of the most predominant of these frameworks.

Identifying 21st Century Skills

We focus on three 21st century skills frameworks. We could have included others, but 21st century skills frameworks tend to be fairly overlapping in what they cover. Two frameworks, Assessment and Teaching of 21st Century Skills (ATC21S, see Binkley et al., 2010) and; Finegold and Notabartolo (2008), were developed primarily through literature reviews and reviews of other 21st century skills frameworks. The third was developed by one of the most influential groups in the 21st century skills movement, the Partnership for 21st Century Skills (P21). As will be evident in the following paragraphs, most 21st century skills frameworks demonstrate a great deal of overlap. Each of the three frameworks is discussed briefly below.

Table 1 lists categories of skills as defined by the three frameworks. The *analytic skills, interpersonal skills, ability to execute, information processing,* and *capacity for change* categories were put forth by Finegold and Notabartolo (2008); the *living in the world* category was put forth by ATC21S; and the *core subjects and 21st century themes* category was put forth by P21. Each of the 21st century skills identified in the three frameworks can be placed into one of these categories.

Table 1

Skills Identified by Three 21st Century Skills Frameworks

Category	Skill	ATC21S	Finegold & Notabartolo (2008)	P21
Analytic skills	Critical thinking	X	X	X
	Problem solving	X	X	X
	Decision making	X	X	
	Research and inquiry		X	
Interpersonal skills	Communication	X	X	X
	Collaboration	X	X	X
	Leadership and responsibility		X	X
Ability to execute	Initiative and self-direction		X	
	Productivity		X	
Information processing	Information literacy	X	X	X
	Media/ICT literacy	X	X	X
	Digital citizenship		X	
	ICT operations and concepts		X	
Capacity for change	Creativity/innovation	X	X	X
	Adaptive learning/ learning to learn	X	X	
	Flexibility		X	
Living in the world	Citizenship/civic literacy	X		X
	Life and career	X		X
	Personal and social responsibility	X		
Core subjects and 21st century themes	Mastery of core academic subjects			X
	Global awareness			X
	Financial, economic, business, and entrepreneurial literacy			X
	Health literacy			X
	Environmental literacy			X

Note. ATC21S = Assessing and Teaching of 21st Century Skills; P21 = Partnership for 21st Century Skills; ICT = information and communication technology.

Finegold and Notabartolo (2008) developed their framework by conducting a literature review that focused on the requirements of the future workplace. Their final framework placed skills within five categories: *analytic skills, interpersonal skills, ability to execute, information processing*, and *capacity for change.*

The ATC21S organization developed its framework by employing a group of workforce experts (Binkley et al., 2010). These experts synthesized several national 21st century skills learning curricula recently developed by the European Union, Organization for Economic Cooperation and Development, the United States (P21; National Academy of Sciences), Japan, Australia, Scotland, England, Northern Ireland, and the International Society for Technology in Education. Their final framework placed skills into four categories: *ways of thinking*, *ways of working*, *tools for working*, and *living in the world*. The first three categories of these skills fit well within the Finegold and Notabartolo (2008) framework and thus are placed there. The fourth is included as a separate category.

Finally, P21 has been an extremely influential entity in the 21st century skills movement. It was founded in 2002 with support from America Online, Cisco, Microsoft, and the U.S. Department of Education (Partnership for 21st Century Skills, 2012). It has employed panels of experts to define a framework for 21st century learning. This includes skills categorized as *core subjects and 21st century themes*; *learning and innovation skills*; *information, media, and technology skills*; and *life and career skills*. Each of the skills that compose each category fit nicely into the Finegold and Notabartolo (2008) framework except core subjects and 21st century themes.

The set of skills in Table 1 likely has intuitive appeal for most readers. After all, who would argue that skills such as problem solving, creativity, and communication are not at least somewhat important for most occupations? In addition to their intuitive appeal, these skills seem to reflect the changes in the economy and in the ways of doing work described above (Apte et al., 2008; Autor et al., 2003; Levy & Murnane, 2004; National Research Council, 2008). For example, working well with others is essential to a service economy, and this is reflected in skills such as communication, cooperation, and social responsibility. In addition, working in an information economy requires several of the skills identified, including problem solving, decision making, and research and inquiry. Note that most of these skills reflect tasks that cannot be done by computers (e.g., think creatively) or ones that involve a proficiency in using

computers (e.g., ICT literacy). In sum, prevalent 21st century skills frameworks appear to be consistent with, and likely influenced by, research on the changing economy.

Although these frameworks certainly hold intuitive and theoretical merits, their empirical merits may be lacking. Existing 21st century skills frameworks are largely developed by groups of experts theorizing which skills are, or should be, considered most important. Undoubtedly, these experts are knowledgeable about these issues. However, people (even experts) can at times over- or underestimate the value of certain skills or completely miss the value of specific skills altogether. What is needed, then, is a way to verify expert judgment with large-scale data. In the current paper, we propose to identify the skills considered most important by using the Occupational Information Network (O*NET) database, an extensive job analysis containing data on 974 occupations, developed and maintained by the U.S. Department of Labor. O*NET is described in more detail below (see Peterson, Mumford, Borman, Jeanneret, & Fleishman, 1999; Peterson et al., 2001; Tippins & Hilton, 2010, for more information). Although we recognize that several competencies are occupation-specific in terms of their importance, the overall goal of the current analysis is to identify a small set of competencies that are considered important for most jobs. Note that from this point forward, in discussing O*NET and our analysis we use the term *competencies* to refer to the omnibus term *skills* as used thus far, so as to avoid any confusion related to O*NET's narrower use of the term *skill* (see below).

O*NET

Overview

O*NET is a comprehensive database of worker and occupational characteristics that is continually updated through surveying a broad range of workers and job analysts. The database, available to the public free of cost, contains descriptions of the knowledge, skills, abilities, interests, and general work activities associated with each occupation. One goal of O*NET is to identify the competencies necessary for people to develop and thrive in the constantly changing American workforce.

History of O*NET

In an effort to match the competencies of workers to jobs during the Great Depression, the U.S. Department of Labor conducted an analysis of tens of thousands of occupations, resulting in the first edition of the *Dictionary of Occupational Titles* (DOT), which, for over 50

years, provided descriptive information, such as worker temperaments, worker interests, working conditions, and training times (Dunnette, 1999). Although the DOT had been used for various purposes over the years, several shortcomings eventually became clear. Critics argued that the information was outdated, overly job-specific, and that the structure of the DOT did not easily facilitate comparisons across jobs. Another major complaint was that the information included in the DOT did not tell workers which competencies were essential to succeed in a job (Peterson et al., 2001).

The Advisory Panel for the Dictionary of Occupational Titles (APDOT) noted that there was a need for a more comprehensive data system that identified necessary competencies for the labor market and established workplace competency guidelines and standards, as the 21st century approached (see U.S. Department of Labor, 1993). Thus began the construction of a more current occupational database that contained information about job requirements, attributes, and contextual information about the occupations (Dye & Silver, 1999).

In February 1993, APDOT released its final report, *The New DOT: A Database of Occupational Titles for the Twenty-First Century*, which discussed APDOT's assertion that further development of the existing DOT system could provide national benchmarks for individual and groups of occupations, aiding in the standardization of terminology across domains and sectors. In 1995, the U.S. Department of Labor first used the term *Occupational Information Network* (O*NET) to describe its new occupational tool (Dye & Silver, 1999). DOT titles are crosswalked to O*NET occupation codes (see http://www.onetonline.org/crosswalk/DOT/).

O*NET Framework

The key organizing framework of O*NET is a taxonomy of occupational descriptors known as the *O*NET content model* (Tippins & Hilton, 2010). The O*NET content model provides a framework, based on job and organizational research and principles, to identify the most important types of occupational information. The model was developed in part to address three needs: (a) the ability to describe occupations in many ways, (b) a common language of work descriptors that can be applied across all occupations, and (c) a taxonomic classification system (Peterson et al., 2001). The model contains 277 descriptors collected by O*NET programs.

Descriptors are either worker-oriented or job-oriented in this framework and are classified into six domains. Worker-oriented descriptors (e.g., competencies) are *worker characteristics*, *worker requirements*, and *experience requirements.* Job-oriented descriptors are: *occupational requirements*, *workforce characteristics*, and *occupation-specific information* (O*NET Resource Center, n.d.a). This structure allows for a focus on specific attributes and key characteristics of workers as well as occupations (Research Triangle Institute, 2007). The elements of the content model, number of ratings per descriptor, and source of ratings are displayed in Table 2.

Because our focus in the current study is on identifying the critical, trainable competencies of workers, our use of O*NET focuses on aspects of the worker characteristics and worker requirements domains. Each of these is described in more detail below. Furthermore, we provide a running example of the characteristics and requirements considered most important from a specific occupation, nurses. For the interested reader, a summary of the rest of the content model can be found in National Center for O*NET Development (n.d.).

Worker characteristics are defined as "enduring characteristics that may influence both work performance and the capacity to acquire knowledge and skills required for effective work performance" (National Center for O*NET Development, n.d., p. 1). O*NET worker characteristics include: abilities, occupational interests, work values, and work styles. In our analysis we will focus on abilities and work styles, as they are characteristics that can be improved. For example, one can work on improving one's written comprehension (ability) and attention to detail (work style). Changes in values (e.g., independence) or interests (e.g., artistic), while possible, are rarer. In fact, meta-analysis has revealed that vocational interests tend to be highly stable, even more stable than personality (Low, Yoon, Roberts, & Rounds, 2005).

Abilities refer to one's capability to perform various types of tasks (e.g., verbal, physical, sensory, mathematical). The O*NET ability taxonomy is based on Fleishman and Reilly's (1992) taxonomy of abilities, which includes 52 specific abilities, 15 more general abilities, and four abilities at the most general level. This taxonomy is hierarchical, with the abilities of one level nested in the more general levels (Tippins & Hilton, 2010). All taxonomies presented in this paper, including competency definitions, are presented in the appendix.

Table 2

O*NET Content Model, Number of Ratings per Descriptor, and Rating Source for Each Rating

O*NET descriptor	Number of ratings	Rating source
(1) Worker characteristics		
Abilities	52	Analysts
Work styles	16	Job incumbents
Occupational interests[a]		
Work values[a]		
(2) Worker requirements		
Skills	35	Analysts
Knowledge	33	Job incumbents
Education[a]		Job incumbents
(3) Experience requirements[a]		
Experience & training[a]		
Skills[a]		
Entry requirement[a]		
Licensing[a]		
(4) Occupational requirements[a]		
Generalized work activities[a]		Job incumbents
Detailed work activities[a]		
Organizational context[a]		
Work context[a]		Job incumbents
(5) Workforce characteristics		
Labor market information[a]		
Occupational outlook[a]		
(6) Occupational specific information		
Tasks[a]		Job incumbents
Tools & technology[a]		

Note. Analysts and job incumbents provide importance ratings (1 to 5 scale) and level ratings (1 to 7, behaviorally anchored rating scale). The two ratings are correlated $r = .95$, so we only analyze importance ratings in this study.

[a] Not analyzed in this paper.

Work styles are the dispositional or personality requirements of the occupation (Tippins & Hilton, 2010). During the construction of O*NET, the term *work style* was used rather than *personality* to emphasize that these are occupationally related personal characteristics (Tippins & Hilton, 2010). The O*NET work styles taxonomy was developed by examining existing

taxonomies of personality (e.g., the Big Five; Digman, 1990) and research on the prediction of performance with personality (e.g., Barrick & Mount, 1991). For a comprehensive review of this literature, see Kyllonen, Lipnevich, Burrus, and Roberts (in press). The O*NET work styles taxonomy includes 16 work styles, which are nested within seven more general work styles.

To provide one example from an actual occupation, for registered nurses, the highest rated ability is problem sensitivity, and the highest rated work style is concern for others.

Worker requirements refer to descriptions of work-related attributes that are attained and/or developed through one's education and/or experiences. Subdomains of the O*NET work requirements category include skills, knowledge, and education. In the current study, we focus on skills and knowledge.

In general, skills are defined as strategies and procedures for acquiring and working with the knowledge that comes with experience and practice (Tippins & Hilton, 2010). In O*NET, 35 skills are divided into basic and cross-functional skills. Basic skills describe the capacities one has that assist in the learning process and the acquisition of knowledge. Content skills (reading comprehension, active listening, writing, etc.) and process skills (active learning, critical thinking, etc.) are included in this grouping. Cross-functional skills refer to competencies such as social skills, complex problem solving, technical skills, systems skills (e.g., judgment and decision making), and resource management skills. These skills are considered necessary for a wide range of jobs and tasks.

Knowledge refers to a collection of facts about a domain that are interrelated (Tippins & Hilton, 2010). The O*NET knowledge taxonomy consists of 33 competencies, nested within 10 more general competencies. It was developed by referring to existing job analysis research, including, but not limited to, the *Fleishman Job Analysis Survey* (Fleishman, 1992) and a job analysis of the U.S. Office of Personnel Management (Corts & Gowing, 1992).

Again, to provide one example from an actual occupation,for registered nurses, the highest rated skill is social perceptiveness, and the highest rated knowledge is medicine and dentistry.

Development of the O*NET Database

The O*NET database began with O*NET 98 and has been updated at least yearly since 2001 (see Tippins & Hilton, 2010, for more detail). Currently, the database includes data on 974 occupations.

A two-stage design is employed in selecting occupations to survey. First, a sample of businesses is selected, "with probability proportional to the expected number of employed workers in the specific occupations being surveyed" (Tippins & Hilton, 2010, p. 81). A sample of employees (job incumbents) is then selected from each of these businesses to complete the surveys. In attempt to faithfully represent the distribution of the workforce, employees from smaller businesses of fewer than 50 employees are undersampled, whereas employees from larger businesses of more than 250 employees are oversampled.

Job incumbents provide ratings for: knowledge, generalized work activities (GWA), work context, education, work styles, and tasks. Each incumbent completes information about domains or about tasks and background information. There are three questionnaires. One questionnaire combines knowledge, work styles, and education and training. Knowledge and work styles are measured with 49 importance scales (see below) and 33 level scales (see below). Education and training is measured with five multiple-choice items. Another questionnaire focuses solely on GWA questions and consists of 41 importance scales and 41 level scales. Finally, a third questionnaire asks only about work contexts and consists of 57 three- and five-point scale items. All questionnaires are identical across occupations. Total time for each questionnaire is approximately 30 minutes.

Analyst ratings. Analysts, graduate students trained in an occupation-related field (e.g., industrial-organizational psychology), rate both the abilities and skills domains. The abilities questionnaire consists of 52 importance and 52 level items, and the skills questionnaire consists of 35 importance and 35 level items. The decision to use analysts rather than incumbents to make these ratings seems to be based partly on practical considerations, such as cost (Tippins & Hilton, 2010). In making their ratings, analysts first read incumbent ratings about the most important GWAs and work context descriptors for each occupation. They are presented with a similar set of information when they rate skills (Tippins & Hilton, 2010). They do not directly observe or interview incumbents. According to Tippins and Hilton (2010), 31 analysts have thus far participated in data collection.

Scale types. The first scale type is importance scales. An example importance question for the abilities competency *oral comprehension* is, "How important is ORAL COMPREHENSION to the performance of *your current job*?" Definitions are also provided for each descriptor. The definition provided for oral comprehension is, "The ability to listen to and

understand information and ideas presented through spoken words and sentences." Each item is rated on a 1 (not important) to 5 (extremely important) scale.

The second type of scale, level scales, are 7-point behaviorally anchored rating scales that are used to rate the level of the competency required to perform an occupation. To develop anchors, subject matter experts created behavioral examples of each level of the competency (Tippins & Hilton, 2010). A second set of subject matter experts then placed these behaviors on the appropriate rating scale point. Criteria for choosing anchors included covering a range of points on the scale, high agreement among subject matter experts, and relevance for rating occupational requirements (Tippins & Hilton, 2010).

An example level question for the O*NET ability *oral comprehension* is, "What level of ORAL COMPREHENSION is needed to perform *your current job*?" (Analysts respond to this item even though they are not working in the job.) There are three behavioral anchors on the 7-point scale: above Point 2 is, "Understand a television commercial"; above Point 4 is, "Understand a coach's oral instructions for a sport"; and above Point 6 is, "Understand a lecture on advanced physics." It is important to note that importance and level items seem to be measuring the same thing, as pretesting indicated that these were correlated at $r = .95$ (Peterson et al., 1999). Because the two scale types seem to measure the same thing, and because the importance items are more directly related to our research question, we focus on the importance scales in the current paper.

Preliminary O*NET data collection revealed that interrater reliability estimates were acceptable, with most competencies reaching at least .70, with an average of 10 raters (Peterson et al., 2001). This led to the requirement of 15 raters per competency to ensure sufficient reliability.

Job zones. It is also important to note that O*NET data include a five-level *Job Zone* variable (O*NET Online, n.d.). Job zones group occupations primarily by their approximate educational requirements: Zone 1 (no high school degree required), 2 (high school education required), 3 (vocational or associate's degree), 4 (bachelor's degree), and 5 (at least some graduate education). Because we are interested in the college-educated workforce, we focus the current analyses on Zones 3 to 5.

Current Study

The goal of the current study was to utilize the O*NET database to identify the most important competencies for the college-educated workforce of the 21st century. We did so in three ways. First, descriptive analyses were conducted on the importance ratings for the O*NET knowledge, skills, abilities, and work styles domains for Job Zones 3 to 5. Next, because several of the competencies seemed to overlap, a principal component analysis (PCA) was conducted to identify a small number of identifiable and interpretable components of these data. PCA was selected over analyses such as exploratory factor analysis (EFA) because our main objective is to condense the dimensionality of competency variables, so that we can use a manageable number of variables in further analysis, for instance, cluster analysis. Factor analysis, as a tool to explore the correlation structure among variables, relies on the concept of latent variables, the scores of which are unknown. The factor score estimates provided by some computer packages do not correspond to the true factor scores. Due to these reasons, we deemed PCA as the more appropriate analysis. Finally, to provide an additional indicator of component importance, we correlated component scores with (log) occupational wages, the logic being that the competency importance should be reflected in the market's willingness to pay for those competencies. We then identified the most important components from the PCA in developing our final skills framework by comparing our results to the previously reviewed frameworks

Method

Database

O*NET database 15.0 was used in the current analysis. This database was last updated in June 2010. As we were concerned with the college educated workforce, we limited our analysis to the 240 Zone 3 occupations, 170 Zone 4 occupations, and 126 Zone 5 occupations, totaling 536 occupational ratings per competency.

Measures

Identically worded items are used to rate the importance of each O*NET skill, with each taking the form, "How important is <knowledge/skill/ability/work style> to the performance of your current job?" Ratings are made on a 5-point scale where 1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important.

Results

Descriptive Analyses

Means and standard deviations were first calculated for all O*NET competency ratings across all occupations. We then identified the 10 highest rated competencies regardless of domain, both collapsed across job zones and within individual job zones, and the 10 highest rated knowledge, skills, abilities, and work styles, both combined across job zones and within individual job zones. Furthermore, for each competency, we identified the percentage of occupations for which this competency was rated as either very important or extremely important on the 5-point importance scale.

To make reports generated by O*NET easier for users to interpret, all scale scores are converted to 0–100 scores using the following formula:

$$S = ((O - L) / (H - L)) * 100,$$

where S is the standardized score, O is the original rating score on the scale, L is the lowest possible score on the original rating scale, and H is the highest possible score on the original rating scale (O*NET Resource Center, n.d.b). All analyses were conducted on the transformed 100-point scales.

Across All Competencies

The 10 highest rated competencies in terms of importance across all domains are listed in Table 3. As can be seen, the competencies that are most commonly thought of as important are work styles. Tables A5 through A7 present the highest rated competencies disaggregated by job zone. Once again, the table is dominated by work styles competencies. The only two exceptions are the ability of oral expression and the knowledge of English language, which are two of the top 10 in Zone 5.

Knowledge

Table 4 displays the highest rated competencies in the O*NET knowledge domain across job zones, and Tables A8 through A10 display the highest rated knowledge competencies disaggregated by job zone. There is high rank order consistency across job zones. For example, *knowledge of English language* is rated as second most important knowledge competency for Zone 3 occupations, and the most important knowledge competency for occupations in Zones 4

and 5. Furthermore, *customer and personal service* is the most important knowledge competency for Zone 3 occupations, second most important for Zone 4 occupations, and third most important for Zone 5 occupations.

Table 3

Descriptive Statistics for Top 10 Competencies Across All Domains and Zones

Competency	Domain	M	SD	% important
Dependability	Work styles	87	6	97
Attention to detail	Work styles	87	7	95
Integrity	Work styles	86	9	88
Cooperation	Work styles	80	8	75
Initiative	Work styles	79	7	77
Self-control	Work styles	77	11	62
Stress tolerance	Work styles	77	11	60
Analytical thinking	Work styles	77	12	59
Adaptability/flexibility	Work styles	76	8	60
Persistence	Work styles	76	8	59

Note. $N = 536$. % important = percentage of occupations rating competencies as either very important or extremely important.

Table 4

Descriptive Statistics for Top 10 Competencies in the O*NET Knowledge Domain

Knowledge	M	SD	% important
English language	70	14	39
Customer & personal service	62	18	28
Mathematics	55	17	12
Computers & electronics	54	17	12
Education & training	52	18	14
Administration & management	52	15	7
Clerical	45	14	3
Psychology	41	22	9
Law & government	41	20	7
Public safety & security	40	19	5

Note. $N = 536$. %. important = percentage of occupations rating competencies as either very important or extremely important.

Skills

Table 5 displays the highest rated skills competencies, and Tables A11 through A13 display the highest rated skills competencies disaggregated by job zone. Several skills related to communication (e.g., active listening, speaking, reading comprehension) are rated as important overall and across zones.

Table 5

Descriptive Statistics for Top 10 Competencies in the O*NET Skill Domain

Skill	M	SD	% important
Active listening	70	9	33
Speaking	69	11	37
Critical thinking	68	8	28
Reading comprehension	67	11	28
Judgment & decision making	61	9	8
Complex problem solving	60	9	6
Writing	60	12	12
Monitoring	60	8	6
Social perceptiveness	58	11	10
Time management	58	8	1

Note. $N = 536$. % important = percentage of occupations rating competencies as either very important or extremely important.

Abilities

Table 6 displays the highest rated abilities, and Tables A14 through A16 display the highest abilities disaggregated by job zone. As is the case in the skills competencies, abilities are largely dominated by competencies related to communication (e.g., oral expression, written comprehension).

Work Styles

The previously discussed Table 3 displays the highest rated work styles, and Tables A17 through A19 display the highest rated work styles disaggregated by job zone. Competencies related to conscientiousness (e.g., attention to detail, dependability) seem to be considered the most important competencies in this domain.

Table 6

Descriptive Statistics for the Top 10 Competencies in the O*NET Abilities Domain

Ability	M	SD	% important
Oral expression	73	11	51
Oral comprehension	73	9	51
Problem sensitivity	69	9	30
Written comprehension	69	11	37
Deductive reasoning	66	8	19
Speech clarity	66	10	21
Near vision	65	6	6
Inductive reasoning	65	10	19
Written expression	64	12	20
Speech recognition	63	8	10

Note. $N = 536$. % important = percentage of occupations rating competencies as either very important or extremely important.

Discussion of Descriptive Analyses

In terms of both mean scores and percentage of occupations for which the competency was rated as very important or extremely important, the descriptive analysis was largely dominated by work styles. That is, all 10 of the competencies considered most important were work styles, which were considered important across most occupations. Furthermore, work style competencies had lower standard deviations on average than the other O*NET domains, indicating that work style competencies were more universally valued across occupations than were other competencies. In addition, other factors that seemed to be important across the majority of occupations were those related to communication skills (e.g., oral expression, oral comprehension) and problem solving/reasoning (e.g., critical thinking, deductive reasoning). As should be evident, however, several of these factors are largely redundant, and it is conceivable that the structure of the O*NET data can be simplified to increase interpretability. In attempt to accomplish this goal, a PCA was conducted.

Principal Component Analyses (PCAs)

The variance-covariance structure of the O*NET data was examined by principal component analysis. PCA is a useful tool to (a) condense large-scale data into a more manageable dimensionality and (b) interpret the correlational relationship among the competencies. The resulting principal components are linear combinations of the competencies under study and can replace the observed competencies and be used as input in further analyses. For more technical information about the formation of principal components, the reader is directed to Johnson and Wichern (2003).

To appropriately conduct the PCA, it was necessary to group both job zones and competencies. Thus, all 536 occupations across all job zones were included in the PCA. A decision was made to group competencies according to the theoretical grouping provided by the O*NET content model. As previously described, the O*NET descriptors are classified into six domains. Knowledge and skills are classified under worker requirements, while abilities and work styles are under worker characteristics (see Table 2). In accordance with this classification, separate PCAs were conducted, that is, an analysis of knowledge and skills (worker requirements) competencies, and an analysis of abilities and work styles (worker characteristics) competencies. Each part included 68 competencies. The resulting ratio of sample size to number of competencies in either part was close to 8 and deemed reasonable.

Because the objective of PCA is to recover a relatively small set of principal components to explain as much of the systematic variability as possible, a major problem when running PCA is to balance the trade-off between the number of components retained and the amount of variation explained. In the current study, we referred to parallel analysis (PA) results (O'Conner, 2000) of the correlation matrices to decide the suggested number of principal components.

In PA, the eigenvalues of the PCA correlation matrix are compared to those of a randomly generated correlation matrix with the same dimensionality. The i^{th} principal component will be retained only if the i^{th} largest eigenvalue of the PCA correlation matrix is larger than the corresponding eigenvalue of the generated data. The correlation matrices of the worker requirements combination and worker characteristics combination were analyzed independently, and the numbers of components were determined according to the two separate PCAs. After the number of components was determined, we used the SAS procedure factor (PROC FACTOR) with the oblique promax rotation option to run the PCA. The components

were labeled according to the rotated result. We chose oblique rotation over orthogonal rotation because oblique rotation allows the components to be correlated, which results in simpler structure. SAS PROC FACTOR has two options with regard to rotation: orthogonal varimax rotation and oblique promax rotation. Because we preferred oblique rotation over orthogonal rotation, we used oblique promax rotation in SAS.

Based on the 536 occupation entries in Zones 3 to 5, the PA suggested nine components for the O*NET worker requirements combination and seven components for the O*NET worker characteristics combination. Considering the interpretability of the components, we chose to identify eight components for O*NET worker requirements and seven for O*NET worker characteristics. The resulting component loading matrices are shown in Tables 7 and 8; to aid the reader, the key variables of each component were grouped together, and only loadings larger than or equal to 0.3 are listed. For both the O*NET worker requirements and O*NET worker characteristics analyses, the component loading matrices exhibited simple structures: Most of the rating variables had only one component loading that is larger than 0.4, each component is represented by a distinct subset of variables, and the variables in the same subset have intrinsic connections that help to name the components.

For the O*NET worker requirement variables, eight components were identified that correspond to the following labels: problem solving, mechanical skills, service orientation, cultural literacy, business literacy, science literacy, civic literacy, and information processing.

For the O*NET worker characteristics variables, seven components were identified that correspond to the following labels: athleticism, visual acuity, fluid intelligence, communication skills, teamwork, achievement/innovation, and attention to detail/near vision. The names of the components are also listed in Tables 7 and 8.

Discussion of the Principal Component Analyses (PCAs)

Eight O*NET worker requirements and seven O*NET worker characteristics components were clearly identified. These components were composed of several variables that, when investigated as a whole, could be meaningfully labeled. One potentially problematic component was the attention to detail/near vision component in the O*NET worker characteristics PCA, which included only two variables that loaded over .40. We retained attention to detail/near vision as a component because attention to detail was the second most important competency across all domains and job zones in the descriptive analysis.

Table 7

Component Loading Matrix of the O*NET Worker Requirements Variables

O*NET descriptor	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7	Comp 8
Management of personnel resources	**.83** [a]							
Monitoring	**.82** [a]							
Systems evaluation	**.80** [a]							
Judgment and decision making	**.79** [a]							
Complex problem solving	**.78** [a]							
Learning strategies	**.76** [a]			.30				
Systems analysis	**.75** [a]							
Critical thinking	**.74** [a]							
Instructing	**.73** [a]			.36				
Active learning	**.73** [a]							
Coordination	**.72** [a]							
Time management	**.72** [a]							
Negotiation	**.60** [a]							
Persuasion	**.53** [a]				.37			
Reading comprehension	**.46** [a]							
Writing	**.44** [a]							
Active listening	**.44** [a]		.35					
Speaking	**.46** [a]							
Mathematics (S)	**.41** [a]							
Troubleshooting		**.96** [a]						
Equipment selection		**.93** [a]						
Equipment maintenance		**.92** [a]						
Repairing		**.91** [a]						
Operation monitoring		**.86** [a]						
Quality control analysis		**.83** [a]						
Operation and control		**.81** [a]						
Installation		**.78** [a]						
Mechanical		**.75** [a]						
Technology design		**.53** [a]						.35
Engineering and technology		**.49** [a]						
Medicine and dentistry			**.84** [a]			**.65** [a]		
Customer and personal service			**.83** [a]		**.54** [a]			
Therapy and counseling			**.82** [a]					
Service orientation			**.76** [a]					
Psychology			**.75** [a]	.30				
Social perceptiveness	**.43** [a]		**.59** [a]					
History and archeology				**.75** [a]				
Fine arts				**.74** [a]				

O*NET descriptor	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7	Comp 8
Philosophy and theology			.34	**.63** [a]				
Communications and media				**.56** [a]				**.48** [a]
Sociology and anthropology			**.44** [a]	**.54** [a]				
Education and training	.36			**.52** [a]				
Foreign language				**.51** [a]				
Sales and marketing					**.86** [a]			
Administration and management					**.66** [a]			
Management of financial resources	**.43** [a]				**.64** [a]			
Economics and accounting					**.64** [a]			
Management of material resources	**.48** [a]				**.57** [a]			
Production and processing		.37			**.49** [a]			
Personnel and human resources					**.44** [a]			
Operations analysis					.40			
Design		.39			.34			
Biology			.37			**.90** [a]		
Chemistry						**.87** [a]		
Science						**.86** [a]		
Physics		**.40** [a]				**.60** [a]		
Mathematics (K)						.40		
Food production						.33		
Transportation							**.72** [a]	
Public safety and security		**.48** [a]					**.71** [a]	
Law and government							**.67** [a]	
Geography				.36			**.64** [a]	
Building and construction							**.47** [a]	
Computers and electronics								**.84** [a]
Telecommunications		**.46** [a]						**.74** [a]
Programming								**.50** [a]
English language								.40
Clerical			.32					.36

Note. Mathematics (S) is the rating variable mathematics in the O*NET skills subdomain. Mathematics (K) is the rating variable mathematics in the O*NET knowledge subdomain. Comp = component, Comp 1 = problem solving, Comp 2 = mechanical skills, Comp 3 = service orientation, Comp 4 = cultural literacy, Comp 5 = business literacy, Comp 6 = science literacy, Comp 7 = civic literacy, Comp 8 = information processing.

[a] Indicates factor loadings > .40; also indicated by boldface.

Table 8

Component Loading Matrix of the O*NET Worker Characteristics Variables

O*NET descriptor	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7
Gross body coordination	**.95** [a]						
Stamina	**.94** [a]						
Dynamic strength	**.92** [a]						
Gross body equilibrium	**.86** [a]						
Trunk strength	**.86** [a]						
Dynamic flexibility	**.83** [a]						
Extent flexibility	**.82** [a]						
Static strength	**.78** [a]						
Explosive strength	**.69** [a]						
Speed of limb movement	**.55** [a]	**.48** [a]					
Multi-limb coordination	**.52** [a]						
Arm-hand steadiness	.37						.30
Manual dexterity	.31						.31
Night vision		**1.08** [a]					
Peripheral vision		**1.05** [a]					
Glare sensitivity		**.98** [a]					
Sound localization		**.98** [a]					
Spatial orientation		**.97** [a]					
Rate control		**.57** [a]					
Depth perception		**.55** [a]					
Response orientation		**.54** [a]					
Reaction time		**.54** [a]					
Far vision		**.44** [a]	**.61** [a]				
Auditory attention		.37	.30				
Information ordering			**.85** [a]				
Category flexibility			**.83** [a]				
Flexibility of closure			**.80** [a]				
Perceptual speed			**.75** [a]				
Speed of closure			**.74** [a]				
Number facility			**.70** [a]				
Mathematical reasoning			**.65** [a]				
Selective attention			**.64** [a]				
Problem sensitivity			**.62** [a]	**.44** [a]			
Memorization			**.58** [a]				
Fluency of ideas			**.58** [a]			**.46** [a]	
Visual color discrimination			**.50** [a]				
Time sharing			**.49** [a]		**.42** [a]		
Visualization			**.49** [a]				
Oral expression				**.80** [a]			
Written comprehension				**.76** [a]			

O*NET descriptor	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7
Oral comprehension				**.74** [a]	.34		
Inductive reasoning			**.50** [a]	**.74** [a]			
Written expression				**.73** [a]			
Deductive reasoning			**.58** [a]	**.69** [a]			
Speech clarity				**.68** [a]	.33		
Integrity				**.49** [a]	.37		.32
Speech recognition			.38	**.43** [a]	**.48** [a]		
Self-control					**.89** [a]		
Cooperation					**.84** [a]		
Social orientation					**.83** [a]		
Concern for others					**.81** [a]		
Stress tolerance					**.80** [a]		
Dependability					**.76** [a]		
Adaptability/flexibility					**.66** [a]		
Leadership				.30	**.45** [a]	.39	
Innovation						**.91** [a]	
Achievement/effort						**.83** [a]	
Persistence						**.81** [a]	
Initiative						**.75** [a]	
Originality			**.46** [a]			**.53** [a]	
Analytical thinking				.39		**.52** [a]	.37
Independence						**.52** [a]	
Attention to detail							**.68** [a]
Near vision			.37				**.59** [a]
Finger dexterity			.31				.36
Control precision							.34
Wrist-finger speed							.31
Hearing sensitivity			.39				

Note. Comp = component, Comp 1 = athleticism, Comp 2 = visual acuity, Comp 3 = fluid intelligence, Comp 4 = communication skills, Comp 5 = teamwork, Comp 6 = achievement/ innovation, Comp 7 = attention to detail/near vision.

[a] Indicate factor loadings > .40; also indicated by boldface.

Ranking of Principal Components

In addition to the 68 worker requirements and 68 worker characteristics competency scores, each occupation now also has component scores on the eight O*NET worker requirements and seven O*NET worker characteristics components. The component scores are linear combinations of the competency scores using the regression weights suggested by the PCA results. Notice that even though the competency scores are non-negative, the component

scores can be negative because the regression weights are not restricted to be non-negative. In PCA, the regression weights reflect the variance-covariance structure of the data; therefore, it is normal to have negative weights.

Then we used the mean component scores over the 536 occupations to rank the identified components. In general, components can be considered more important as their scores increase. The ranking results are largely consistent with the descriptive analyses and are displayed in Tables 9 and 10. Components that largely consist of work styles (e.g., teamwork, achievement/innovation), communication skills, and problem solving (which is partially composed of several communication-related competencies) related competencies have higher mean component scores. One difference from the descriptive analyses that did emerge was that the fluid intelligence component was rated as very important.

To give the reader a sense of the component score distribution for each component, we provide histograms that display component scores along the *x*-axis and frequency of occupations along the *y*-axis. Figure 1 displays histograms for O*NET worker requirements components and Figure 2 displays histograms for O*NET worker characteristics components. The location on the *x*-axis denotes the component score level, and the height of each bar indicates the number of occupations at given component score levels. As the histograms suggest, the component score distribution varies greatly from component to component. Taking Figure 1 as an example, the problem-solving component scores are mostly between 500 and 1,400 and center on about 1,000. However, the mechanical skills component scores are mostly between -500 and 500 and center on about 0, which explains why the mean component score of mechanical skills is negative in Table 9. It should be emphasized again that the component scores rely on job analysts' or job incumbents' judgment on each competency variable and the regression weights from PCA. One should not interpret them as absolute importance indicators when reading the numbers.

Correlation With Wages

There were 11 occupations for which wage data were not available, thereby reducing the overall sample size to 525. Additionally, the underlying distribution of wages was positively skewed (ratio of skewness to its standard error was about 10, whereas the generally accepted threshold is 3.3). Therefore, a log transformation was applied, and this reduced skewness to virtually 0. We then correlated component scores with log-transformed wages. Correlations are displayed in Table 11. The table shows that the components with the four largest relationships

with wages are also four of the top five ranked in terms of importance. Of the top five components in terms of importance, only teamwork is not correlated with wages. When interpreting these data, one should be careful to keep in mind that the O*NET data are taken at the job level. Thus, one should read the first correlation in Table 11 as meaning that jobs that require good communication skills tend to be paid more, and not individuals with good communication skills tend to be paid more.

Table 9

Composite Scores and Rank Orders of O*NET Worker Requirements

Component	Rank order	Mean component score
Problem solving	1	969.65
Business literacy	2	305.73
Science literacy	3	273.38
Civic literacy	4	254.83
Information processing	5	249.21
Service orientation	6	234.53
Cultural literacy	7	192.93
Mechanical skills	8	-106.45

Table 10

Composite Scores and Rank Orders of O*NET Worker Characteristics

Component	Rank order	Mean component score
Fluid intelligence	1	785.85
Teamwork	2	778.95
Achievement/innovation	3	537.24
Communication skills	4	309.22
Attention to detail/near vision	5	234.30
Visual acuity	6	145.30
Athleticism	7	137.58

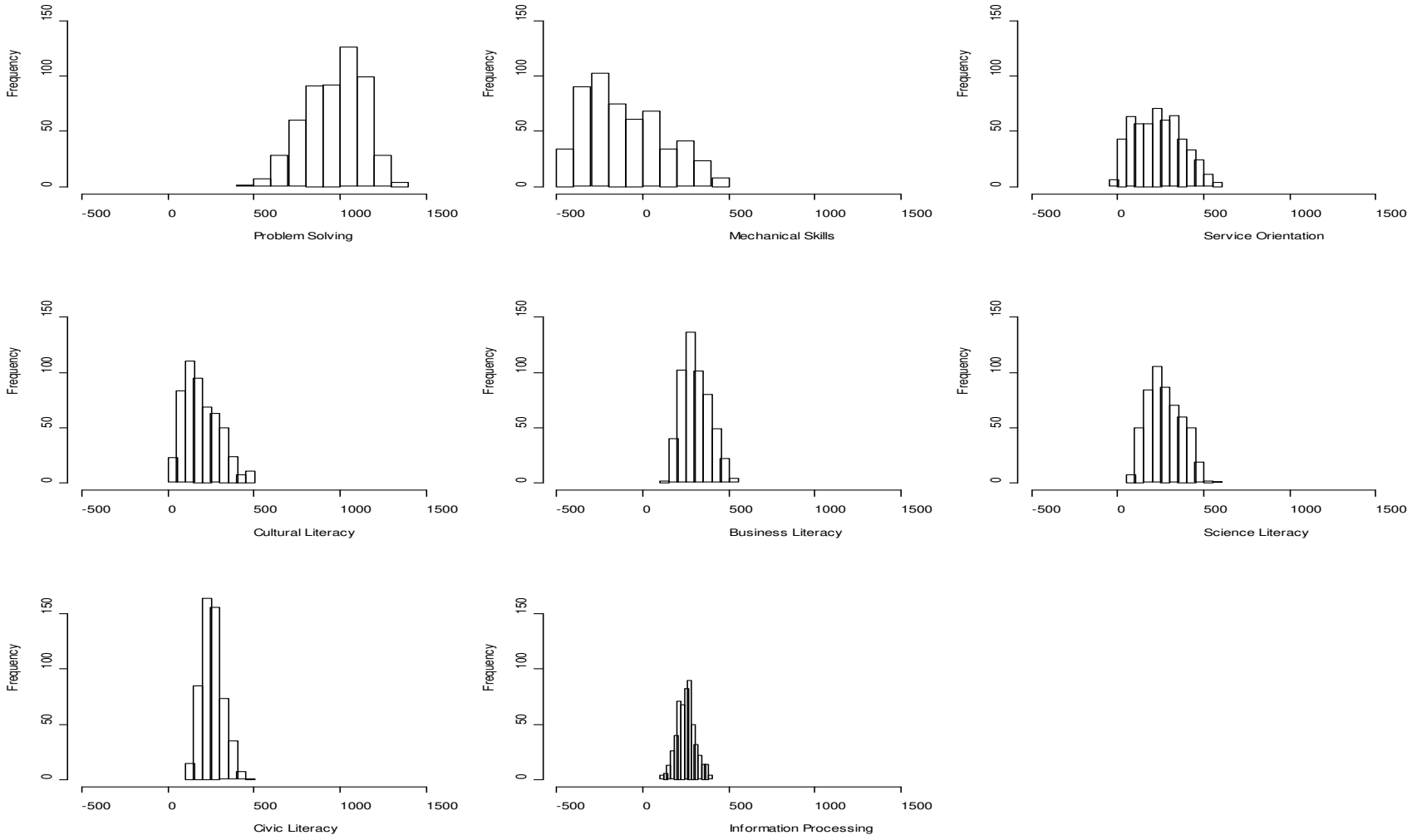

***Figure 1*. Histograms of O*NET worker requirements components. Numbers along the *x*-axis represent component scores. Numbers along the *y*-axis represent the frequency of occupations at each level of component scores.**

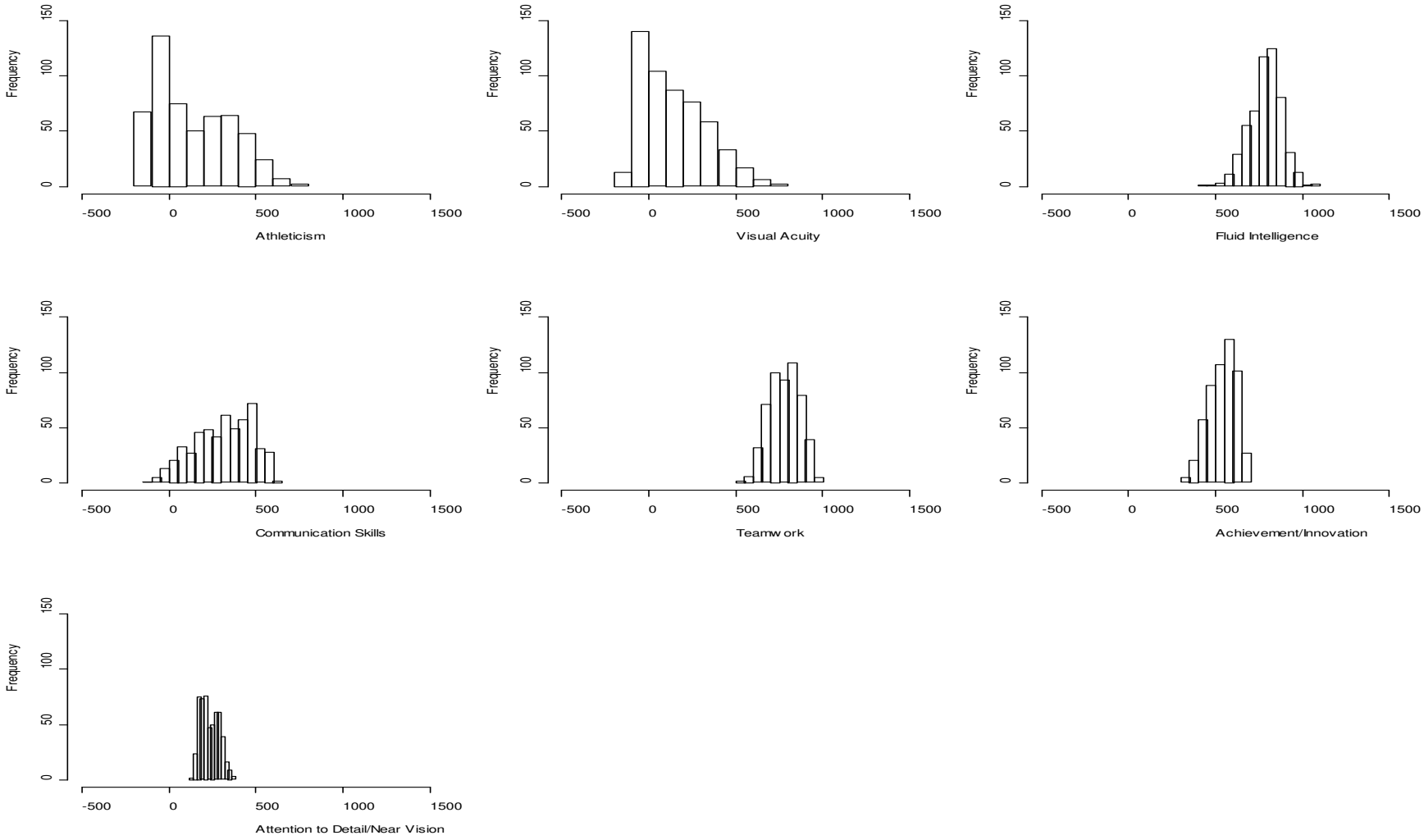

***Figure 2*. Histograms of O*NET worker characteristics components. Numbers along the *x*-axis represent component scores. Numbers along the *y*-axis represent the frequency of occupations at each level of component scores.**

Table 11

Correlation of Components With Log-Transformed Wages

Component	Correlation with wages
Communication skills	.60
Problem solving	.58
Achievement/innovation	.46
Fluid intelligence	.41
Information processing	.30
Science literacy	.29
Business literacy	.19
Civic literacy	.14
Cultural literacy	.13
Attention to detail	.13
Service orientation	.10
Teamwork	-.004
Mechanical skills	-.16
Visual acuity	-.23
Athleticism	-.41

Final 21st Century Workforce Competencies Framework

Although 15 O*NET components were identified by the PCA, a comparison of these components with the descriptive analyses shows that it is clearly not the case that all of these components are considered important for success in most occupations. To select components for our final framework, we compared the components identified by the current analysis with the competencies identified by previous frameworks (see Table 1). We did so in recognition of the fact that, although the O*NET database is a useful resource for the creation of a competencies framework, it is likely not perfect. For instance, the O*NET database could be biased by problems such as item wording effects, rater bias, and insufficient content coverage. Furthermore, our data analytic strategy may have led to conclusions that would diverge from a different analytic strategy. Thus, we gain valuable convergent validity evidence by comparing the current analysis to previously developed frameworks.

Four categories of competencies were identified by all three frameworks: analytic skills, interpersonal skills, information processing, and capacity for change. The top five ranked components in the current analysis correspond to three of these categories: problem solving (analytic skills), fluid intelligence (analytic skills), teamwork (interpersonal skills), achievement/innovation (capacity for change), and communication skills (interpersonal change). Although all three frameworks identified information processing as an important competency, it was ranked as the ninth most important component out of 15 in the current analysis.

Thus, our final 21st century workforce competencies framework consists of five components: problem solving, fluid intelligence, teamwork, achievement/innovation, and communication skills (see Figure 3). In addition to considering mean component importance ratings, is important to also note variance in these ratings. An examination of Figures 1 and 2 reveals that there are indeed some differences in the ranges component importance ratings. For example, although problem solving and fluid intelligence have higher mean scores than intelligence, there are a few occupations that score higher on teamwork than the other two components. This underscores the point that the goal of the current analysis is to identify the most important competencies overall, rather than identify competencies that are considered important for every occupation.

Furthermore, correlating components with log-transformed wages revealed that four of the five components of our framework were strongly related to wages, providing evidence that these competencies are highly valued in the workforce. Teamwork did not correlate with wages. However, we retain teamwork in our framework because it was the second highest rated component in terms of importance and because it is considered important in each of the three reviewed frameworks.

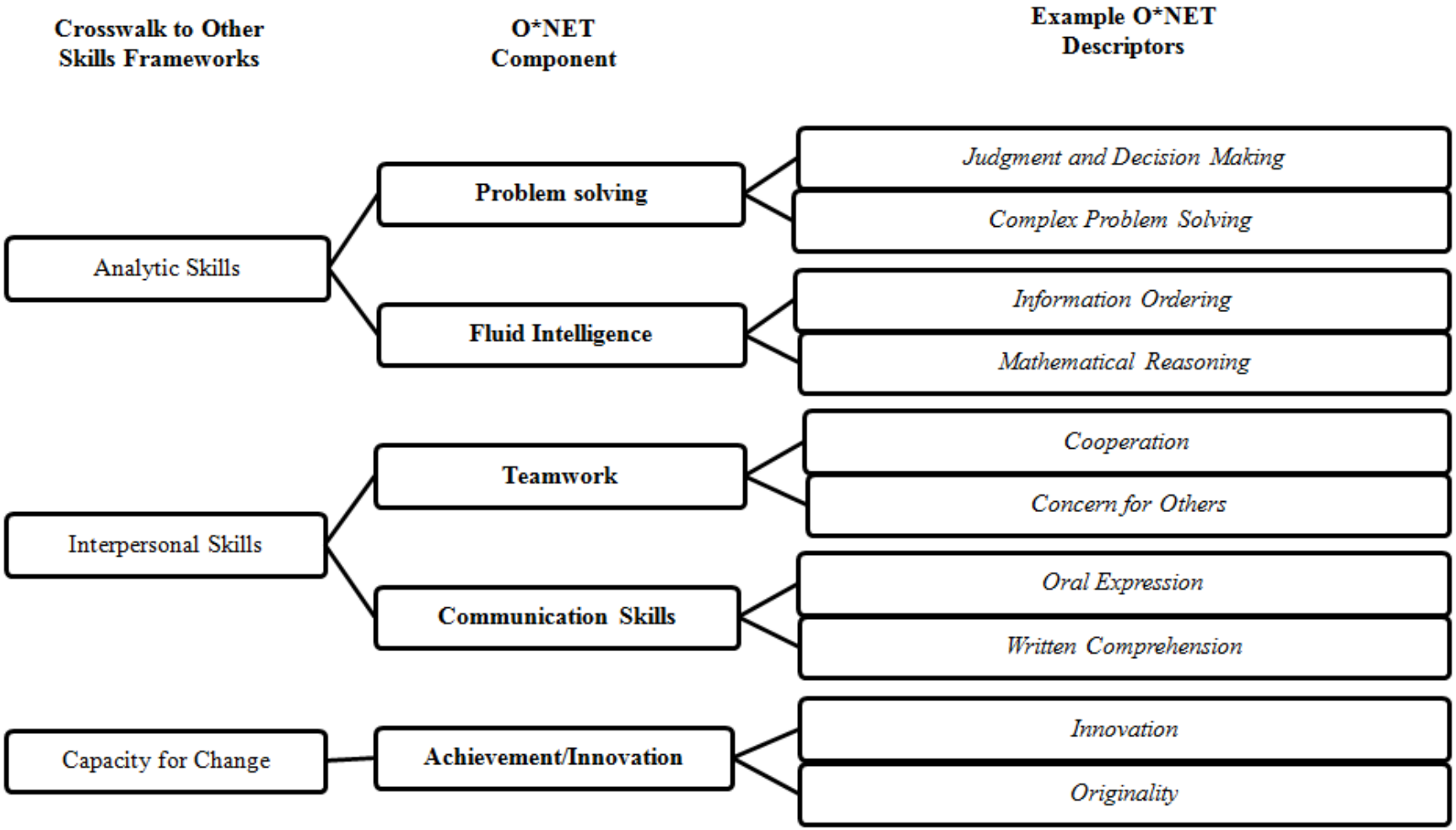

***Figure 3*. Twenty-first century workforce competencies framework.**

General Discussion

Summary of Findings

Several organizations have attempted to identify the most important skills and competencies needed for the 21st century workforce (e.g., Binkley et al., 2010; Finegold & Notabartolo, 2008; P21, 2012). Typically, these frameworks have been developed through expert panel discussions and/or by reviewing the extant research literature. In the current study, we took a different approach by developing a 21st century skills framework with a data-driven method. Specifically, we conducted an analysis of the O*NET knowledge, skills, abilities, and work styles variables of the Department of Labor's O*NET database. Descriptive and principal component analyses revealed consistent findings. A comparison of these findings with previous frameworks resulted in a final set of five important 21st century competencies: problem solving, fluid intelligence, teamwork, achievement/innovation, and communication skills. Correlating these competencies with wages indicated that, with the exception of teamwork, each competency was significantly and positively related to wages. To reiterate a previous warning, when interpreting these data, one should be careful to keep in mind that the O*NET data are taken at the job level, rather than the individual level. As such, jobs that require skills such as communication and problem-solving skills tend to pay more.

Does the U.S. Workforce Possess These Skills?

Our analysis suggests competencies that are important for the U.S. workforce, but it does not speak to the extent to which the workforce possesses these skills. This is clearly an area ripe for future research, although some recent survey research has spoken to this issue. In one previously mentioned study (Casner-Lotto & Barrington, 2006), researchers surveyed 431 employers across the United States and asked them to indicate whether new entrants into positions at their companies were *deficient*, *adequate*, or *excellent* on 20 basic job knowledge/skills. Several of the job knowledge/skills rated correspond roughly to some of the skills identified in the current study. Results for corresponding skills for 2- and 4-year college graduates are presented in Table 12. They suggested that a substantial proportion of new entrants in the workforce were deficient in communication skills and teamwork and that this deficiency was most pronounced for 2-year graduates. Perhaps surprisingly, there was very little perceived deficiency in information processing skills.

Table 12

Skill Deficiencies Identified in Casner-Lotto and Barrington (2006) and Crosswalk to Current Results

Are they ready to work? component	O*NET competency	Rated deficient: 2-year college graduates	Rated deficient: 4-year college graduates
Written communications	Communication skills	47%	28%
Writing in English	Communication skills	46%	26%
Leadership	Teamwork	43%	24%
Self-direction	Achievement/innovation	28%	14%
Creativity/innovation	Achievement/innovation	28%	17%
Critical thinking/problem solving	Problem solving	23%	9%
Oral communications	Communication skills	21%	10%
Reading comprehension	Communication skills	13%	5%
Teamwork/collaboration	Teamwork	12%	8%
English language	Communication skills	11%	4%
Information technology application	Information processing	8%	3%

Other recent surveys have focused on workforce skills and have indicated gaps of some of these skills, although few to date have found gaps in all five of the competencies (i.e., problem solving, fluid intelligence, teamwork, communication skills, and achievement/innovation). A recent study commissioned by Deloitte and The Manufacturing Institute surveyed 1,123 executives in the manufacturing industry across all 50 states (Deloitte & The Manufacturing Institute, 2011). These executives were asked to respond to several items, including one that asked them to identify the most serious skills deficiencies in their current employees, with several of the skills identified as gaps overlapping with the O*NET competencies. *Inadequate problem-solving skills* was identified by 52% of executives. *Inadequate basic employability skills* (which included *work ethic*) was identified by 40% of executives. Work ethic can be interpreted as similar, if not identical, to the achievement/effort and persistence components of the achievement/innovation competencies. Furthermore*, inadequate math skills* (a component of the fluid intelligence competency) was identified by 30% of executives, and 29% identified *poor communication* as a skill gap.

Finally, Hart Research Associates (2010) conducted a survey of 302 employers whose organizations have at least 25 employees for the Association of American Colleges and Universities. The employers interviewed in this study noted that colleges should increase their focus on a number of skills, including several that directly align with the O*NET competencies addressed in the current framework. Specifically, they thought colleges should place more emphasis on written and oral communication (89% of employers), critical thinking (a component of the problem-solving competency; 81%), complex problem solving (a component of the problem-solving competency; 75%), ethical decision making (a component of the problem-solving competency; 75%), teamwork (71%), and innovation and creativity (a component of the achievement/innovation competency; 70%).

These studies provide evidence that education systems, and workplaces themselves, should focus more on teaching certain competencies frequently considered deficient in new workforce entrants (e.g., written communications). However, a more comprehensive study is required before one makes strong inferences about skill deficiencies. Future studies should employ a larger, more representative sample of employers commensurate with the O*NET database. Furthermore, it may be beneficial to explore the idea of adding items to the O*NET

questionnaires concerning the extent to which employees in occupations possess the competencies being rated. Such questions can serve to illuminate the skills gap in more detail.

Future Research

In addition to the research just described, there are several other possible areas of future research that can be conducted. First, more work should be done on finding ways to group O*NET variables together and rank-order them in terms of importance. That is, research should investigate improvements to our current method (e.g., conducting a PCA and creating importance scores for the resulting components). Although we did find identifiable components in the current study, determining which of these components is most important was difficult. One potential issue is that there may be overlap among some components. For example, several competencies that fell under the problem-solving component are communication related. Thus, the true value of the communication skills component may be underestimated in our analysis. Future research should examine ways to improve the comparability of all O*NET components.

Furthermore, research should focus on determining whether the data from O*NET can be used to describe jobs and workers from other countries. An increasingly global business community means that workers are likely to transfer to jobs in different countries to a greater extent than ever before. Thus, it is imperative that a system for determining whether those workers are qualified to move into jobs into different countries exists. O*NET may be that system. In fact, some research has found that O*NET skill and work styles variable importance is comparable across several countries (i.e., United States, New Zealand, China, and Hong Kong), although that work should be replicated and extended (Taylor, Kan Shi, & Borman, 2008).

Finally, future work should focus on examining whether competency importance varies by job zone or job type. In the current study, it was necessary to aggregate across job zones to perform the PCA. An examination of ways to simplify the structure of the O*NET data for individual job zones would be a worthwhile endeavor. Our descriptive analyses suggest that results would be very similar across job zones, but one cannot definitively know whether important differences emerge across job zones before conducting a more complete analysis. Additionally, analyses could be conducted to examine whether families of jobs can be identified that share a common set of skills. The results of such an analysis can ultimately prove useful for career counseling purposes.

Additional Study Limitations

A few other study limitations should be addressed. First, it is important to remember that O*NET ratings represent incumbent and analysts' implicit theories of competency importance. Although these raters are informed, it is not necessarily the case that the competencies they think are most important are actually predictive of job performance, satisfaction, or retention. To build a database such as this that provides a prediction score for each of the competencies in O*NET would likely be extremely (if not prohibitively) expensive, as it would essentially require a separate study to be conducted for each occupation. This would mean 536 studies would have to be conducted if a study were conducted for each occupation included in the current paper.

The fact that competencies were rated by two different types of raters (i.e., incumbents and analysts) may be problematic. Because competency type ratings are confounded with rater type (e.g., abilities are rated by analysts; work styles are rated by incumbents), it is difficult in the current study to examine whether analysts systematically differ in their ratings from incumbents. Future research may be useful that focuses on identifying possible rater effects in the O*NET database.

Another important limitation to consider is that the current data analyses were largely exploratory in nature. Although we were informed by the O*NET content model in the current paper, the analyses were largely data, rather than theory, driven. As such, it may be interesting for future work to test a new theory of how work competencies should group together and examine whether the new findings replicate the current ones.

A final point of limitation to remember is that the O*NET database is continually being updated. In fact, the database we used for the current study was updated during the time this paper was written. Database updates tend to be minor, only affecting a few occupations at a time. Nonetheless, over the course of a few years, accumulated updates could have a major impact on the final competency list that would emerge from a similar analysis. Thus, it may be important to update these analyses periodically in parallel with database updates.

Conclusion

The current study represents an initial foray into using O*NET to develop a 21st century workforce competencies framework. The final set of competencies deemed most important in our analysis was composed of problem solving, fluid intelligence, teamwork, achievement/innovation, and communication skills. These skills are important for many, if not

most, of the occupations classified by the U.S. Department of Labor. This suggests that the emerging workforce should be trained in these skills if the United States is to remain a viable competitor in the global economy.

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Appendix

Table A1

O*NET Ability Taxonomy and Definitions

Ability taxonomy	Definition
Cognitive	
Verbal	
Oral comprehension	The ability to listen to and understand information and ideas presented through spoken words and sentences.
Written comprehension	The ability to read and understand information and ideas presented in writing.
Oral expression	The ability to communicate information and ideas in speaking so others will understand.
Written expression	The ability to communicate information and ideas in writing so others will understand.
Idea generation and reasoning	
Fluency of ideas	The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity).
Originality	The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
Problem sensitivity	The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing that there is a problem.
Deductive reasoning	The ability to apply general rules to specific problems to produce answers that make sense.
Inductive reasoning	The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
Information ordering	The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
Category flexibility	The ability to generate or use different sets of rules for combining or grouping things in different ways.
Quantitative	
Mathematical reasoning	The ability to choose the right mathematical methods or formulas to solve a problem.
Number facility	The ability to add, subtract, multiply, or divide quickly and correctly.
Memory	
Memorization	The ability to remember such information as words, numbers, pictures, and procedures.

Ability taxonomy	Definition
Perceptual	
Speed of closure	The ability to quickly make sense of, combine, and organize information into meaningful patterns.
Flexibility of closure	The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material.
Perceptual speed	The ability to quickly and accurately compare similarities and differences among sets of letters, numbers, objects, pictures, or patterns. The things to be compared may be presented at the same time or one after the other. This ability also includes comparing a presented object with a remembered object.
Spatial	
Spatial orientation	The ability to know your location in relation to the environment or to know where other objects are in relation to you.
Visualization	The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.
Attentiveness	
Selective attention	The ability to concentrate on a task over a period of time without being distracted.
Time sharing	The ability to shift back and forth between two or more activities or sources of information (such as speech, sounds, touch, or other sources).
Psychomotor	
Fine manipulative	
Arm-hand steadiness	The ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.
Manual dexterity	The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.
Finger dexterity	The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
Control movement	
Control precision	The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.
Multi-limb coordination	The ability to coordinate two or more limbs (for example, two arms, two legs, or one leg and one arm) while sitting, standing, or lying down. It does not involve performing the activities while the whole body is in motion.
Response orientation	The ability to choose quickly between two or more movements in response to two or more different signals (lights, sounds, pictures). It includes the speed with which the correct response is started with the hand, foot, or other body part.
Rate control	The ability to time your movements or the movement of a piece of equipment in anticipation of changes in the speed and/or direction of a moving object or scene.

Ability taxonomy	Definition
Reaction time and speed	
Reaction time	The ability to quickly respond (with the hand, finger, or foot) to a signal (sound, light, picture) when it appears.
Wrist-finger speed	The ability to make fast, simple, repeated movements of the fingers, hands, and wrists.
Speed of limb movement	The ability to quickly move the arms and legs.
Physical	
Physical strength	
Static strength	The ability to exert maximum muscle force to lift, push, pull, or carry objects.
Explosive strength	The ability to use short burst of muscle force to propel oneself (as in jumping or sprinting) or to throw an object.
Dynamic strength	The ability to exert muscle force repeatedly or continuously over time. This involves muscular endurance and resistance to muscle fatigue.
Trunk strength	The ability to use your abdominal and lower back muscles to support part of the body repeatedly or continuously over time without giving out or fatiguing.
Endurance	
Stamina	The ability to exert yourself physically over long periods of time without getting winded or out of breath.
Flexibility, balance, and coordination	
Extent flexibility	The ability to bend, stretch, twist, or reach with your body, arms, and/or legs.
Dynamic flexibility	The ability to quickly and repeatedly bend, stretch, twist, or reach out with your body, arms, and/or legs.
Gross body coordination	The ability to coordinate the movement of your arms, legs, and torso together when the whole body is in motion.
Gross body equilibrium	The ability to keep or regain your body balance or stay upright when in an unstable position.
Sensory	
Visual	
Near vision	The ability to see details at close range (within a few feet of the observer).
Far vision	The ability to see details at a distance.
Visual color discrimination	The ability to match or detect differences between colors, including shades of color and brightness.
Night vision	The ability to see under low-light conditions.
Peripheral vision	The ability to see objects or movement of objects to one's side when the eyes are looking ahead.

Ability taxonomy	Definition
Depth perception	The ability to judge which of several objects is closer or farther away from you, or to judge the distance between you and an object.
Glare sensitivity	The ability to see objects in the presence of a glare or bright lighting.
Auditory and speech	
Hearing sensitivity	The ability to detect or tell the differences between sounds that vary in pitch and loudness.
Auditory attention	The ability to focus on a single source of sound in the presence of other distracting sounds.
Sound localization	The ability to tell the direction from which a sound originated.
Speech recognition	The ability to identify and understand the speech of another person.
Speech clarity	The ability to speak clearly so others can understand you.

Note. Adapted from "The O*NET Content Model," by O*NET Resource Center (n.d.).

Table A2

O*NET Work Style Taxonomy and Definitions

Work style taxonomy	Definition
Achievement orientation	
Achievement/effort	Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.
Persistence	Job requires persistence in the face of obstacles.
Initiative	Job requires a willingness to take on responsibilities and challenges.
Social influence	
Leadership orientation	Job requires a willingness to lead, take charge, and offer opinions and direction.
Interpersonal orientation	
Cooperative	Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.
Concern for others	Job requires being sensitive to others' needs and feelings and being understanding and helpful to others on the job.
Social orientation	Job requires preferring to work with others rather than alone, and being personally connected with others on the job.
Adjustment	
Self-control	Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.
Stress tolerance	Job requires accepting criticism and dealing calmly and effectively with high-stress situations.

Work style taxonomy	Definition
Adaptability/flexibility	Job requires being open to change (positive or negative) and to considerable variety in the workplace.
Conscientiousness	
Dependability	Job requires being reliable, responsible, and dependable, and fulfilling obligations.
Attention to detail	Job requires being careful about details and thorough in completing tasks.
Integrity	Job requires being honest and ethical.
Independence	
Independence	Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.
Practical intelligence	
Innovative	Job requires creativity and alternative thinking to develop new ideas for and answers to work-related problems.
Analytical thinking	Job requires analyzing information and using logic to address work-related issues and problems.

Note. Adapted from "The O*NET Content Model," by O*NET Resource Center (n.d.).

Table A3

O*NET Skill Taxonomy and Definitions

Skill taxonomy	Definition
Basic	
Content	
Reading comprehension	Understanding written sentences and paragraphs in work-related documents.
Active listening	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
Writing	Communicating effectively in writing as appropriate for the needs of the audience.
Speaking	Talking to others to convey information effectively.
Mathematics	Using mathematics to solve problems.
Science	Using scientific rules and methods to solve problems.
Process	
Active learning	Understanding the implications of new information for both

Skill taxonomy	Definition
	current and future problem solving and decision making.
Learning strategies	Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.
Monitoring	Monitoring/assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
Critical thinking	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
Cross-functional	
Complex problem solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
Social	
Social perceptiveness	Being aware of others' reactions and understanding why they react as they do.
Coordination	Adjusting actions in relation to others' actions.
Persuasion	Persuading others to change their minds or behavior.
Negotiation	Bringing others together and trying to reconcile differences.
Instruction	Teaching others how to do something.
Service orientation	Actively looking for ways to help people.
Technical	
Operations analysis	Analyzing needs and product requirements to create a design.
Technology design	Generating or adapting equipment and technology to serve user needs.
Equipment selection	Determining the kind of tools and equipment needed to do a job.
Installation	Installing equipment, machines, wiring, or programs to meet specifications.
Programming	Writing a computer program for various purposes.
Quality control analysis	Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
Operation monitoring	Watching gauges, dials, or other indicators to make sure a machine is working properly.
Operation and control	Controlling operations of equipment or systems.
Equipment maintenance	Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
Troubleshooting	Determining causes of operating errors and deciding what to do about it.

Skill taxonomy	Definition
Repairing	Repairing machines or systems using the needed tools.
Systems	
Systems analysis	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
Judgment and decision making	Considering the relative costs and benefits of potential actions to choose the most appropriate one.
Systems evaluation	Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.
Resource management	
Time management	Managing one's own time and the time of others.
Management of financial resources	Determining how much money will be spent to get the work done, and accounting for these expenditures.
Managing material resources	Obtaining and seeing the appropriate use of equipment, facilities, and materials needed to do certain work.
Managing personnel resources	Motivating, developing, and directing people as they work, identifying the best people for the job.

Note. Adapted from "The O*NET Content Model," by O*NET Resource Center (n.d.).

Table A4

O*NET Knowledge Taxonomy and Definitions

Knowledge taxonomy	Definition
Business and management	
Administration and management	Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.
Clerical	Knowledge of administration and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.
Economics and accounting	Knowledge of economic and accounting principles and practices, the financial markets, banking, and the analysis and reporting of financial data.
Sales and marketing	Knowledge of principles and methods for showing, promoting, and selling products and services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.

Knowledge taxonomy	Definition
Customer and personal service	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.
Personnel and human resources	Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.
Manufacturing and production	
Production and processing	Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
Food production	Knowledge of techniques and equipment for planting, growing, and harvesting food products (both plant and animal) for consumption, including storage/handling techniques.
Engineering and technology	
Computers and electronics	Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
Engineering and technology	Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
Design	Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
Building and construction	Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
Mechanical	Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
Mathematics and science	
Mathematics	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
Physics	Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic, and sub-atomic structures and processes.
Chemistry	Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production

Knowledge taxonomy	Definition
	techniques, and disposal methods.
Biology	Knowledge of plant and animal organisms and their tissues, cells, functions, interdependencies, and interactions with each other and the environment.
Psychology	Knowledge of human behavior and performance; individual differences in ability, personality, and interests; learning and motivation; psychological research methods; and the assessment and treatment of behavioral and affective disorders.
Sociology and anthropology	Knowledge of group behavior and dynamics, societal trends and influences, human migrations, ethnicity, cultures, and their history and origins.
Geography	Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.
Health services	
Medicine and dentistry	Knowledge of the information and techniques needed to diagnose and treat human injuries, diseases, and deformities. This includes symptoms, treatment alternatives, drug properties and interactions, and preventive health care measures.
Therapy and counseling	Knowledge of principles, methods, and procedures for diagnosis, treatment, and rehabilitation of physical and mental dysfunctions, and for career counseling and guidance.
Education and training	
Education and training	Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.
Arts and humanities	
English language	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
Foreign language	Knowledge of the structure and content of a foreign (non-English) language including the meaning and spelling of words, rules of composition and grammar, and pronunciation.
Fine arts	Knowledge of the theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture.
History and archaeology	Knowledge of historical events and their causes, indicators, and effects on civilizations and cultures.
Philosophy and theology	Knowledge of different philosophical systems and religions. This includes their basic principles, values, ethics, ways of thinking, customs, practices, and their impact on human

Knowledge taxonomy	Definition
	culture.
Law and public safety	
Public safety and security	Knowledge of relevant equipment policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.
Law, government, and jurisprudence	Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.
Communications	
Telecommunications	Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.
Communications and media	Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.
Transportation	
Transportation	Knowledge of principles and methods for moving people or goods by air, rail, sea, or road, including the relative costs and benefits.

Note. Adapted from "The O*NET Content Model," by O*NET Resource Center (n.d.).

Table A5

Descriptive Statistics for Top 10 Competencies for Zone 3

Rank	Competency	M	SD	% important
1	Dependability[a]	87	6	97
2	Attention to detail	87	7	95
3	Integrity	83	10	81
4	Cooperation	79	8	71
5	Self-control	77	11	61
6	Stress tolerance	76	11	58
7	Initiative	76	7	64
8	Adaptability/flexibility	74	9	54
9	Independence	73	9	46
10	Persistence	72	8	43

Note. $N = 240$. % important = percentage of occupations rating competency as either very important or extremely important.

[a] This competency is not from the O*NET work styles domain.

Table A6

Descriptive Statistics for Top 10 Competencies in Zone 4

Rank	Competency	M	SD	% important
1	Attention to detail	88	6	97
2	Integrity	87	8	90
3	Dependability	87	6	96
4	Initiative	81	6	85
5	Cooperation	80	8	79
6	Analytical thinking	79	10	71
7	Adaptability/flexibility	78	8	67
8	Persistence	77	7	63
9	Stress tolerance	77	11	60
10	Self-control	75	11	54

Note. $N = 170$. % important = percentage of occupations rating competency as either very important or extremely important.

[a] This competency is not from the O*NET work styles domain.

Table A7

Descriptive Statistics for Top 10 Competencies for Zones 5

Rank	Competency	M	SD	% important
1	Integrity	91	6	98
2	Dependability	89	7	97
3	Attention to detail	86	7	95
4	Analytical thinking	86	7	91
5	Initiative	84	6	92
6	Independence	82	8	79
7	Oral expression[a]	82	8	87
8	English language[a]	81	10	77
9	Persistence	81	6	78
10	Achievement/effort	81	7	73

Note. $N = 126$. % important = percentage of occupations rating competency as either very important or extremely important.

[a] This competency is not from the O*NET work styles domain.

Table A8

Descriptive Statistics for Top 10 Competencies in the O*NET Knowledge Domain for Zone 3

Rank	Knowledge	M	SD	% important
1	Customer & personal service	64	18	34
2	English language	61	13	14
3	Mathematics	52	15	5
4	Computers & electronics	50	19	11
5	Administration & management	48	15	5
6	Education & training	47	13	3
7	Public safety & security	44	20	8
8	Clerical	44	17	6
9	Mechanical	44	16	15
10	Production & processing	37	20	4

Note. $N = 240$. % important = percentage of occupations rating competencies as either very important or extremely important.

Table A9

Descriptive Statistics for Top 10 Competencies in the O*NET Knowledge Domain for Zone 4

Rank	Knowledge	M	SD	% important
1	English language	73	10	45
2	Customer & personal service	61	16	20
3	Computers & electronics	59	15	15
4	Mathematics	56	18	18
5	Administration & management	56	14	11
6	Education & training	49	17	11
7	Clerical	47	12	1
8	Law & government	45	19	8
9	Communications & media	43	18	9
10	Engineering & technology	40	31	20

Note. $N = 170$. % important = percentage of occupations rating competencies as either very important or extremely important.

Table A10

Descriptive Statistics for Top 10 Competencies in the O*NET Knowledge Domain for Zone 5

Rank	Knowledge	M	SD	% important
1	English language	81	10	77
2	Education & training	68	18	39
3	Customer & personal service	59	19	28
4	Psychology	58	24	25
5	Mathematics	57	19	18
6	Computers & electronics	55	13	10
7	Administration & management	53	14	6
8	Law & government	46	19	8
9	Sociology & anthropology	46	23	11
10	Biology	45	32	30

Note. $N = 126$. % important = percentage of occupations rating competencies as either very important or extremely important.

Table A11

Descriptive Statistics for Top 10 Competencies in the O*NET Skills Domain for Zone 3

Rank	Skill	M	SD	% important
1	Active listening	65	9	16
2	Speaking	63	10	16
3	Critical thinking	63	8	10
4	Reading comprehension	59	9	4
5	Monitoring	57	8	4
6	Judgment & decision making	56	8	3
7	Complex problem solving	55	8	0.4
8	Social perceptiveness	55	10	5
9	Time management	54	8	1
10	Coordination	54	9	3

Note. $N = 240$. % important = percentage of occupations rating competencies as either very important or extremely important.

Table A12

Descriptive Statistics for Top 10 Competencies in the O*NET Skills Domain for Zone 4

Rank	Skill	M	SD	% important
1	Active listening	72	6	40
2	Speaking	71	8	38
3	Reading comprehension	71	6	34
4	Critical thinking	70	6	31
5	Writing	65	8	8
6	Judgment & decision making	64	7	6
7	Complex problem solving	63	7	6
8	Monitoring	61	8	4
9	Time management	60	7	1
10	Coordination	59	9	5

Note. $N = 170$. % important = percentage of occupations rating competencies as either very important or extremely important.

Table A13

Descriptive Statistics for Top 10 Competencies in the O*NET Skills Domain for Zone 5

Rank	Skill	M	SD	% important
1	Speaking	79	9	73
2	Reading comprehension	77	7	68
3	Active listening	76	7	56
4	Critical thinking	75	6	56
5	Writing	71	7	38
6	Judgment & decision making	68	7	18
7	Complex problem solving	67	6	17
8	Active learning	67	6	12
9	Monitoring	65	7	11
10	Social perceptiveness	64	10	19

Note. $N = 126$. % important = percentage of occupations rating competencies as either very important or extremely important

Table A14

Descriptive Statistics for the Top 10 Competencies in the O*NET Abilities Domain for Zone 3

Rank	Ability	M	SD	% important
1	Oral comprehension	68	9	30
2	Oral expression	67	10	28
3	Problem sensitivity	67	9	23
4	Near vision	65	6	5
5	Deductive reasoning	61	6	5
6	Written comprehension	61	10	8
7	Speech clarity	61	9	7
8	Speech recognition	60	7	4
9	Information ordering	59	7	2
10	Inductive reasoning	59	8	5

Note. $N = 240$. % important = percentage of occupations rating competency as either very or extremely important.

Table A15

Descriptive Statistics for the Top 10 Competencies in the O*NET Abilities Domain for Zone 4

Rank	Ability	M	SD	% important
1	Oral comprehension	74	6	56
2	Oral expression	74	7	58
3	Written comprehension	72	7	50
4	Problem sensitivity	70	7	33
5	Deductive reasoning	68	6	20
6	Written expression	68	8	23
7	Speech clarity	67	8	20
8	Inductive reasoning	67	7	16
9	Near vision	66	5	4
10	Speech recognition	65	8	14

Note. $N = 170$. % important = percentage of occupations rating competency as either very or extremely important.

Table A16

Descriptive Statistics for the Top 10 Competencies in the O*NET Abilities Domain for Zone 5

Rank	Ability	M	SD	% important
1	Oral expression	82	8	87
2	Oral comprehension	78	6	83
3	Written comprehension	78	7	73
4	Inductive reasoning	74	7	50
5	Speech clarity	74	7	49
6	Written expression	43	7	52
7	Deductive reasoning	72	6	42
8	Problem sensitivity	71	10	39
9	Speech recognition	66	7	14
10	Near vision	66	6	9

Note. N = 126. % important = percentage of occupations rating competency as either very or extremely important.

Table A17

Descriptive Statistics for the Top 10 Competencies in the O*NET Work Styles Domain for Zone 3

Rank	Work style	M	SD	% important
1	Dependability	87	6	97
2	Attention to detail	87	7	95
3	Integrity	83	10	81
4	Cooperation	79	8	71
5	Self-control	77	11	61
6	Stress tolerance	76	10	58
7	Initiative	76	7	64
8	Adaptability/ flexibility	74	9	54
9	Independence	73	9	46
10	Persistence	72	8	43

Note. N = 240. % important = percentage of occupations rating skills as either very important or extremely important.

Table A18

Descriptive Statistics for the Top 10 Competencies in the O*NET Work Styles Domain for Zone 4

Rank	Work style	M	SD	% important
1	Attention to detail	88	6	97
2	Integrity	87	8	90
3	Dependability	87	6	96
4	Initiative	81	6	85
5	Cooperation	80	8	79
6	Analytical thinking	79	10	71
7	Adaptability/ flexibility	78	8	67
8	Persistence	77	7	63
9	Stress tolerance	77	11	60
10	Self-control	76	11	54

Note. $N = 170$. % important = percentage of occupations rating skills as either very important or extremely important.

Table A19

Descriptive Statistics for the Top 10 Competencies in the O*NET Work Styles Domain for Zone 5

Rank	Work style	M	SD	% important
1	Integrity	91	6	98
2	Dependability	89	7	97
3	Attention to detail	86	7	95
4	Analytical thinking	86	7	91
5	Initiative	84	6	92
6	Independence	82	8	79
7	Persistence	81	6	86
8	Achievement/ effort	81	7	81
9	Cooperation	80	9	78
10	Self-control	80	12	73

Note. $N = 126$. % important = percentage of occupations rating skills as either very important or extremely important.