



# Identifying Critical 21st-Century Skills for Workplace Success: A Content Analysis of Job Advertisements

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This article extends the literature on 21st-century learning skills needed for workplace success by providing an empirical examination of employers' direct communication to potential employees via job advertisements. Our descriptive analysis of 142,000 job advertisements provides two contributions. First, this is one of the first studies to empirically rank-order skill demand. In doing so, it is clear that oral and written communication, collaboration, and problem-solving skills are in high demand by employers, with particular emphasis on the pairing of oral and written communication. Furthermore, it is apparent that many of the skills suggested in the literature as being critical for workplace success are in very low demand by employers, and some were not found to be mentioned at all (e.g., social responsibility). Second, this study explicitly examined whether 21st-century skill demand varied by job characteristics, which was found to be the case, with differences being noted for both education level and degree field requirements. Results were replicated with a sample of roughly 120,000 job advertisements collected 1 year from the initial data collection. Implications for developing educational standards around 21st-century skill development are discussed.

**Keywords:** collaboration; communication; content analysis; critical thinking; descriptive analysis; problem solving; social processes/development; textual analysis

Given rapid social, scientific, and technological changes, the United States is continuing its shift from an industrial- to an information-based economy. As such, in addition to technical and subject-matter expertise, the majority of jobs being created require an increasingly broad skill set to deal with the demands of technological advances and a globalized workforce (Hart Research Associates, 2015; Kirsch et al., 2007). Such skills have been called by many names across research and nonresearch contexts (for a review of terminology, see Duckworth & Yeager, 2015). In this article, we will refer to them as *21st-century skills*, which we define as a combination of cognitive (e.g., nonroutine problem solving, critical thinking, metacognition), interpersonal (i.e., social), and intrapersonal (i.e., emotional, self-regulatory) skills that are malleable (i.e., potentially responsive to intervention) and relatively stable over time in the absence of exogenous forces (e.g., intentional intervention, life events, changes in social roles; Duckworth & Yeager, 2015; Pellegrino & Hilton, 2012). Regardless of the terminology used, prior research has suggested that 21st-century skills predict both academic and workplace success (e.g.,

Almlund et al., 2011). Yet, employers have criticized that recent college graduates lack these skills when entering the workforce (e.g., Goodman et al., 2015; Hart Research Associates, 2015). Therefore, to promote workforce preparedness and long-term success of the U.S. economy, it is clear that student development of 21st-century skills is greatly needed. However, one question remains: What are the vital 21st-century skills necessary for workplace success?

## *Approaches to Identifying Critical 21st-Century Skills*

There have been several attempts to review and organize frameworks around 21st-century skills, drawing from perspectives in psychology, education, and other subdisciplines within these fields (e.g., Kyllonen, 2012; Markle et al., 2013). However, the existing research is mixed about how to conceptualize 21st-century skills and the relative importance or rank-ordering of these skills

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(Duckworth & Yeager, 2015). This may be largely due to methodological differences in the three approaches to developing 21st-century frameworks, which include relying on theorists, using job analysis data, and surveying employers. The theory-driven approach involves incorporating feedback from substantive experts and/or workforce specialists to determine learning outcomes of 21st-century skills. However, we have found that theory-driven frameworks differ largely based on who is synthesizing the skills and for which population the skill development is being conceptualized for. As an example, lifelong, self-directed learning encompasses the ability to continue developing personal attributes and gaining a deeper understanding of one's own workplace and work roles. Although this skill is commonly referenced among employers (Casner-Lotto & Barrington, 2006; Neubert et al., 2015), it is less often highlighted as being of importance in frameworks focused on educational settings populated with children and adolescents in explicitly learning-centered environments. Consequently, when frameworks are developed by theorists, conceptual issues can limit the skills focused on by employers and educators, even within the same broad category of 21st-century skills, making it difficult to understand how to value different skills because of the multitude of unique interpretations.

To avoid the limitations associated with purely theory-driven frameworks, researchers have relied on information obtained from job analyses (e.g., Burrus et al., 2013). A job analysis is the process of collecting data to understand the skills necessary to perform a particular job. One of the most extensive job analysis databases is the Occupational Information Network (O\*NET) developed by the U.S. government to assist students, job seekers, businesses, and workforce development specialists in understanding the skills needed to perform specific jobs in the current economy. Although an intriguing approach, job analyses are limited because they generally (a) are based on very small sample sizes, (b) possess a high degree of subjectivity in identifying skills, and (c) are unable to directly observe certain skills.

Additionally, researchers have directly asked employers about the 21st-century skills needed for their companies (e.g., Hart Research Associates, 2015). Although this strategy provides more direct communication when compared to theoretical and job analysis approaches, a reliance on survey data may be problematic for two reasons. First, the individual answering the survey may not possess adequate knowledge about the variety of skills required for a wide range of employees within a particular organization as they may not be thoroughly connected to employees on the ground. As an example, survey participants can include CEOs, presidents, and executives, whereas managers and low-level employees are less often asked what skills they feel are of most importance (e.g., Hart Research Associates, 2015). Second, survey responses largely occur outside of the hiring context, and as such, the skills identified within a survey may not be accurate enough in comparison to the specific skills required for actual job positions. Employers responding to a survey in abstract may find it easy to state that ideal candidates must possess communication, problem-solving, creativity, and other skills simultaneously. However, the realities of a specific job position are such that certain skills will be more valued than others in practice.

## *An Alternative Approach*

As existing methods to identifying critical 21st-century skills have largely failed to incorporate direct communication between employers and job candidates, an alternative approach is needed. One such approach is conducting a content analysis of online job advertisements, which is advantageous in three ways. First, a job advertisement requires employers to stipulate, in their own words, the skills that they need from their workers. As these advertisements can often be short in length, employers have limited space to include a comprehensive inventory of skills required for the job and instead are more likely to mention highly desirable skills that they worry may not be common in the applicant pool (Burning Glass Technologies, 2015). Furthermore, explicitly linking the key desired skills to specific positions represents a more accurate reading of what employers are looking for in applicants across a variety of jobs. Second, by examining a large number of advertisements, a real-world examination of labor market demands on 21st-century skills can be obtained for diverse job characteristics, such as field, minimum education requirement, and so on. Such information may add to previous suggestions/findings around differential skill demand by job type. Third, analyzing advertisements taken from the Internet will provide a representative sample of positions in the economy as 80% to 90% of all job openings requiring a college degree are now posted online (Carnevale et al., 2014).

## *Study Objective*

The objective of this study was to conduct an empirical investigation of 21st-century skills that are critical for students' transition from higher education (i.e., jobs requiring a college degree) to the workforce by web scraping and conducting content analyses of online job advertisements. Focusing specifically on 21st-century skills needed for college graduates is of particular importance as 99% of the 10.6 million jobs created after the Great Recession have gone to individuals with some form of postsecondary education (Carnevale et al., 2016).<sup>1</sup> The following research questions are addressed:

1. What are the most in-demand 21st-century skills identified in job postings requiring a college degree?
2. How do these skills differ by education level and degree field?

Findings from this study have the potential to assist in signaling the need for building highly in-demand skills—assuming that they are both learnable and malleable—into education and training systems.

## **Method**

To address our study objective, we first conducted a literature review of 21st-century skills to compile a list of terms (i.e., critical 21st-century skills) to be searched for in job advertisements. Upon developing this list, we next had to extract job advertisements from the Internet, code independent variables, and identify the 21st-century skills that were requested by employers

**Table 1**  
**Definitions of 21st-Century Skills Examined**

Skill	Definition	Times Noted in Literature Reviewed
Collaboration	“Build collaborative relationships with colleagues and customers; be able to work with diverse teams, negotiate and manage conflicts” (Casner-Lotto & Barrington, 2006, p.16)	13
Problem solving	Demonstrating the ability to apply critical thinking skills to solve problems by generating, evaluating, and implementing solutions (Burrus et al., 2017)	11
Communication skills	“Effectively communicate multiple types of messages across multiple forms and varying audiences” (Markle et al., 2013, p. 13)	10
Critical thinking	“Exercise sound reasoning and analytical thinking; use knowledge, facts, and data to solve workplace problems” (Casner-Lotto & Barrington, 2006, p. 16)	9
Oral communication	“Articulate thoughts, ideas clearly and effectively” (Casner-Lotto & Barrington, 2006, p. 16)	8
Written communication	“Write memos, letters, and complex technical reports clearly and effectively” (Casner-Lotto & Barrington, 2006, p. 16)	8
Ethics	“Demonstrate integrity and ethical behavior; act responsibly with the interests of the larger community in mind” (Casner-Lotto & Barrington, 2006, p. 16)	8
Cultural sensitivity	“Ability to learn from and work collaboratively with individuals representing diverse cultures, races, ages, gender, religions, lifestyles, and viewpoints” (Casner-Lotto & Barrington, 2006, p. 16)	8
Adaptability	The ability to respond effectively to feedback (Pellegrino & Hilton, 2012)	7
Creativity	“The ability to generate new ideas, novel integration of existing ideas, and application of new ideas in a real-world setting” (Markle et al., 2013, p. 13)	6
Continuous learning	Ability to acquire new knowledge and skills (Casner-Lotto & Barrington, 2006)	6
Self-direction	Demonstrating the ability and flexibility to learn on the job and prepare for future challenge (De Fruyt et al., 2015)	4
Time management	The efficient use of time and management of workload (Binkley et al., 2012)	3
Professionalism	“Demonstrate personal accountability and employing effective work habits” (Casner-Lotto & Barrington, 2006, p. 16)	3
Service orientation	An inclination to be courteous and helpful in dealing with customers (National Research Council, 2011)	3
Leadership	Plan, cultivate, and inspire the success of employees internal to the organization (Burrus & Robert, 2017)	3
Social intelligence	“Ability to connect to others in a deep and direct way, to sense and stimulate reactions and desired interactions” (Burrus et al., 2017, p. 271)	3

from our precompiled list. Next, we describe these processes in greater detail.

### *Literature Review*

A literature review of 21st-century skill frameworks was conducted in Google Scholar. The search terms used were “noncognitive skills,” “21st-century skills,” “workplace skills,” and “applied skills.” Articles or reports providing a framework of critical skills (i.e., more than one skill) for workplace success within the past 20 years were kept, whereas articles focusing on only one skill were excluded. Upon identifying literature via Google Scholar that met the inclusion criterion, multiple rounds of cross-referencing were conducted until no further literature was identified. This literature search was completed between February and August 2017. In total, 16 articles of relevance were included, and content analyses of these articles were conducted to identify reoccurring skills proposed by distinct researchers. As shown in Table 1, we identified 15 distinct 21st-century skills that were referenced in three or more articles. The skills mentioned in 50% or more of the articles reviewed were collaboration ( $n = 13$ ), problem solving ( $n = 11$ ), communication skills ( $n = 10$ ), critical thinking ( $n = 9$ ), oral communication ( $n = 8$ ), written communication ( $n = 8$ ), ethics ( $n = 8$ ), and cultural sensitivity ( $n = 8$ ). As it was expected that individuals writing job advertisements

may use inconsistent terminology in describing the same skills (e.g., adaptability was often referred to as flexibility, responsiveness, or versatility), synonym lists were generated from the PsycINFO and Merriam-Webster thesauri, where possible, and finalized through group consensus. Feedback on the accuracy of the synonym list was made by a hiring resource specialist involved with developing job advertisements for a large corporation. The reoccurring skills and their respective synonyms were used as terms to be searched for in the job advertisements.

### *Web-Scraping Job Advertisements*

Job advertisements were extracted from two major online websites, Careerbuilder.com (one of the largest job aggregation websites on the Internet) and Collegerecruiter.com (a job aggregation website geared toward recent graduates searching for entry-level jobs), between February and April 2017, using a web-scraping application built using Python’s Scrapy library.<sup>2</sup> The raw HTML of each post was parsed to identify “job title,” “description,” “location,” and “company name” fields. Posts were deduplicated based on job description. The unique descriptions were processed to allow for independent variable and skill identification as follows: (a) all text were lowercased; (b) descriptions were split into sentences; and (c) extraneous punctuation (e.g., asterisks and dashed lines, used for formatting), sequences of multiple

spaces, and control characters, such as newlines and tabs, were removed.

### *Independent Variables*

Before identifying 21st-century skills, information was extracted from the processed descriptions where available for education level and degree field/major.

*Education level.* Education level was defined as the lowest degree requirement by an employer. These were grouped into four categories: associate's degree, bachelor's degree, graduate degree (master's, doctoral, or professional degree), and not stated. This variable was identified via a combination of regular expression pattern matching and hand-coded heuristics.

*Degree field.* Degree field was defined as the subject of degree specialization preferred by the employer. Examples include accounting, computer science, and graphic design. Extracting the degree field involved compiling a lexicon of possible college majors from two online college information resources ([www.shmoop.com](http://www.shmoop.com) and [www.jvis.com](http://www.jvis.com)), and using regular expression pattern matching to identify the specification of a degree requirement mentioning one of the majors in the lexicon. Majors were then grouped into the following degree fields: (a) science, technology, engineering, and mathematics (STEM); (b) social sciences; (c) education; (d) business; (e) arts and humanities; and (f) other.

### *21st-Century Skill Identification*

To identify which skills were mentioned in a job advertisement, case-insensitive keyword matching was used. In order to minimize the potential problem of term ambiguity (e.g., a skill term, such as "service oriented," is used in the post to express an aspect of the company instead of a desired trait of the prospective applicant), all keyword matches were filtered using a set of hand-coded heuristics based on a review of randomly sampled data (approximately 300 job posts were sampled per skill). For instance, a match of the term "responsive" in a post was ignored if it co-occurred with language describing web applications (e.g. "optimizing responsive site code"). Although the disambiguation method just described makes an attempt to avoid false positives, its performance is not perfect. In order to quantify the false positive (Type I error) rate of our skill-matching method, annotations were performed on a subset of matched data. Any skill or synonyms of skills that were found to identify false positives at a rate above 5% were dropped from all further analyses. As an example, although leadership was identified to be an important 21st-century skill by three of 16 frameworks, we were unable to distinguish heuristics that would maintain Type I error below 18%. Consequently, this skill was removed from our study. Though, no other skills were dropped based on this criterion.

## **Results<sup>3</sup>**

A total of 203,272 unique job advertisements (86% from Careerbuilder.com and 14% from Collegerecruiter.com) were collected and analyzed. The five occupational fields most

represented in the sample included (a) business, management, and administration (22.4%); (b) information technology (15.4%); (c) finance (12.5%); (d) health science (11.1%); and (e) STEM (10.9%). In terms of minimum education requirement, 67% of the job advertisements collected explicitly required some form of a college degree (14%, associate's; 70%, bachelor's; and 16%, graduate degree). As the objective of this study was to examine 21st-century skills requested for college degree holders, only those jobs explicitly requiring some form of a college degree were kept for further analysis, which led to a final sample size of 141,941 job advertisements. Of those, 28% specified a degree field, and the top five most requested fields were business (25%), accounting (14%), engineering (13%), computer science (11%), and nursing (6%). Full-time employment was specified for nearly 100% of the job advertisements that specified employment type. Figure 1 provides the proportion of job advertisements based on the interaction of degree level and field.

### *21st-Century Skill Demand*

*All jobs.* Of the roughly 142,000 job advertisements analyzed, 70% requested at least one 21st-century skill included in our study, and of these advertisements, the average number of unique skills appearing in a single post was 1.69 ( $Mdn = 1$ ,  $SD = 1.62$ , maximum = 12). The most highly requested skill across all advertisements was oral communication (28%), followed closely by written communication (23%), collaboration (22%), and problem solving (19%). Aside from these skills, only social intelligence (12%) and self-direction (10%) were found to appear in 10% or more of the advertisements in our sample. Furthermore, skills such as professionalism, creativity, adaptability, service orientation, continual learning, and cultural sensitivity were listed in less than 5% of all advertisements (Figure 2). It should be noted that general communication (not specifying either oral or written communication) alone was the fifth most in-demand skill (14%), suggesting that had employers been more specific, the observed percentages of oral and written communication would have been higher. As 73% of job postings ( $n = 103,242$ ) mentioned more than one 21st-century skill, the most popular skill co-occurrences were examined. Results demonstrated that across all job postings, the top five most requested skill co-occurrences were (a) oral and written communication (28%), (b) oral communication and problem solving (10%), (c) oral communication and collaboration (10%), (d) written communication and problem solving (9%), and (e) written communication and collaboration (9%).

*By education level.* Clear differences were noted for some skills by minimum education-level requirements. As an example, oral communication was found to be in greater demand for jobs requiring an associate's degree (22%) when compared to those requiring a bachelor's (16%) or graduate (15%) degree. In addition, collaborative skill demand was observed to progressively increase as the minimal degree requirement increased. Specifically, in proportion to the total number of advertisements at each education level, jobs requiring a doctoral degree demanded collaborative skills by 5% more than those requiring an associate's degree. However, the largest skill demand difference by education

Business	43.8%	54.0%	24.3%
S.T.E.M.	41.5%	34.3%	43.1%
Social Sciences	2.3%	4.6%	23.4%
Education	9.1%	4.2%	5.95%
Arts & Humanities	2.6%	2.5%	3.0%
Other	0.7%	0.4%	0.3%
	Associate Degree (n=19,900)	Bachelor Degree (n=99,964)	Graduate Degree (n=22,077)

FIGURE 1. Proportion of job advertisements based on the interaction of degree level and field.

level was observed for social intelligence. Although there were no differences between bachelor's or graduate degree jobs (i.e., both requested social intelligence in about 6% of advertisements), jobs requiring an associate's degree demanded this skill at twice the rate than jobs requiring a higher degree. Beyond these skills, small differences were noted by education level (Figure 3). In terms of skill co-occurrence, the proportion of jobs that requested more than one 21st-century skill and required an associate's, bachelor's, or graduate degree was 70%, 77%, and 68%, respectively. Similar to the results across all job posts, the most in-demand paired skills were oral and written communication for jobs requiring a bachelor's (28%) or graduate degree (29%), while associate degree-level jobs emphasized the combination of oral communication skills with social intelligence (27%).

*By degree field.* In addition to education level, differences were noted by degree field for two of the top four skills observed for all job postings (Figure 4). Specifically, both oral (16%–17%) and written (14%–17%) communication were found to be listed nearly equally for jobs requesting a degree in the STEM ( $n = 18,318$ ), social sciences ( $n = 2,241$ ), education ( $n = 1,765$ ), and business ( $n = 18,318$ ) fields. However, larger differences were noted between degree fields for collaborative and problem-solving skills. For instance, the former skill was found at a rate that was 50% higher for jobs requiring a social science degree (18%) when compared to those requiring a business degree (12%; the demand was 33% higher for jobs requiring education and social science degrees). In addition, large differences were noted for problem solving, particularly when comparing STEM and social science fields. That is, jobs requiring a STEM field (14%) requested problem-solving skills at a rate that was 75%

higher than social science jobs (8%; Figure 4). In regard to skill co-occurrence, across business, STEM, social science, and education degree fields, the most requested skill co-occurrence was oral and written communication. However, the second most in-demand joint skill for business (11%) and STEM (12%) fields was oral communication and problem solving, whereas in the social science (14%) and education (11%) fields, it was written communication and collaboration. Taken together, the results suggest that 21st-century skill demand is differential by degree field for some skills.

## Discussion

This article extends the literature on 21st-century learning skills needed for workplace success by providing an empirical examination of employers' direct communication to potential employees via job advertisements. Our analysis provides two contributions. First, this is one of the first articles to empirically rank-order skill demand. In doing so, it is clear that oral and written communication, collaboration, and problem-solving skills are in high demand by employers, with particular emphasis on the pairing of oral and written communication. This finding is supported by our systematic review of the literature, which found that across all studies and reports analyzed, these four skills were found to be noted most often. Furthermore, it is apparent that many of the skills suggested in the literature as being critical for workplace success are in very low demand by employers, and some were not found to be mentioned at all (e.g., social responsibility). Second, although previously implied in the literature, homogenous development of 21st-century skills may not be effective in preparing students for workforce entry. This

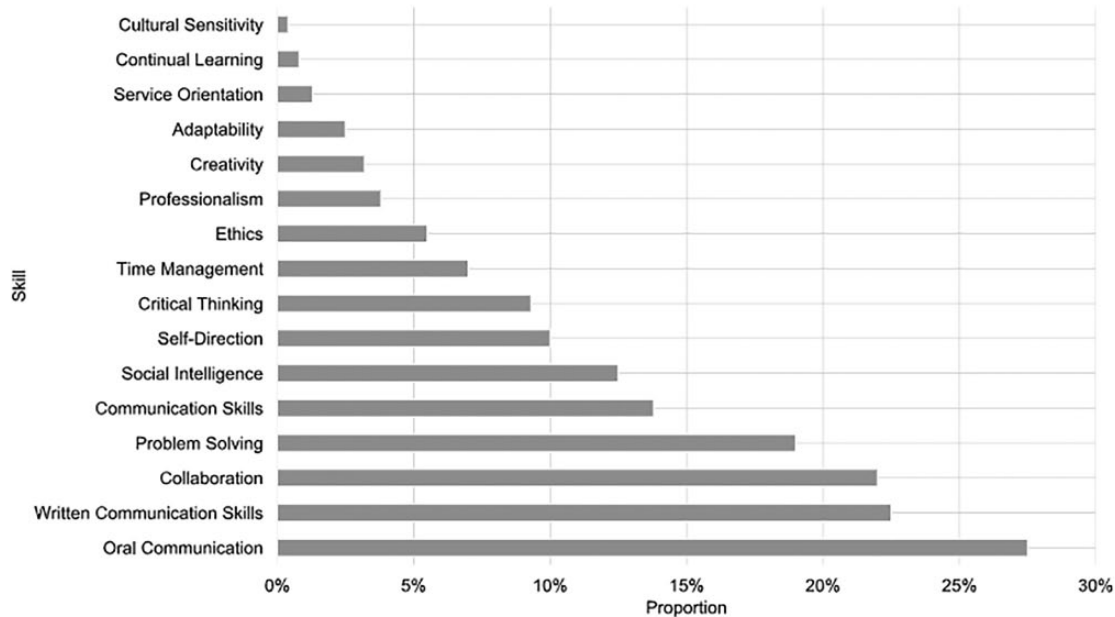


FIGURE 2. 21st-century skill demand expressed as proportion of total job advertisements examined.

assertion is supported by our study, which showed differential demand of some skills by education level and degree field requirements. Overall, these findings provide a more nuanced picture of 21st-century skill requirements for individuals transitioning from postsecondary education to the workforce.

### Limitations

Several limitations associated with this study should be noted. First, although 80% to 90% of all job advertisements can be found online (Carnevale et al., 2014), the advertisements sampled in our study do not represent all online job posts, as we web scraped data from only two websites. Each of these websites required recruiters to pay a fee for marketing their job openings online. Consequently, our findings may have been biased based on the fact that companies lacking financial resources to pay for online recruiting were not included in our sample. In addition, the websites used may have attracted different types of companies and/or jobs based on their intended demographics that may not be representative of the general population. Besides potential bias from the websites sampled, our data may not have been representative of the population of job openings, as our study ignored advertisements posted offline, which may have possessed different characteristics than what we observed in our analysis.

A second limitation associated with our study is that we focused only on job advertisements requiring a postsecondary college credential. Although this is in line with the new jobs being created in the U.S. economy (Carnevale et al., 2016), it is possible that our sample may have been limited, as we required employers to specify the minimum education level to be an associate's, bachelor's, or graduate degree (master's, doctoral, or professional degree). However, it is possible that the terms we used may have unintentionally excluded advertisements that used alternative terminology for degree type or failed to report a required minimum education level, as the job being advertised

would assume a college degree (e.g., physician). In a similar vein, a third limitation of this study was the use of exact word match as the approach to identifying 21st-century skills in job advertisements. Although we evaluated Type I errors to limit the number of false positives in our results, we were unable to assess power or the ability to identify true positives. Therefore, it is possible that employers used alternative language to specify 21st-century skills that we did not search for. To improve power, we attempted to develop synonyms for each term, where possible, based on using thesauri and expert judgment from a hiring specialist who has experience in online marketing of job openings; however, it is unclear how many true positives went undetected. Finally, this study assumed that all 21st-century skills mentioned in job advertisements were of great importance to employers. However, given the limited space available in job advertisements, it is unclear whether employers may have been interested in 21st-century skills that they did not explicitly state. More research is needed to better understand how employers craft their job advertisements to better shed light on the utility of analyzing this source of data.

### Implications

In light of these limitations, our finding that there is a clear-cut demand for a limited number of skills (oral communication, written communication, collaboration, and problem solving) points to two implications. First, although framed as critical to the 21st-century worker, these skills have long been important to both higher education institutions and employers. Since 1977, U.S. higher education institutions have begun reform efforts to improve the state of general education programs, as many critics (e.g., the Carnegie Foundation for the Advancement of Teaching) have felt that college students lack generic capabilities for workforce success (Gaff, 1981). Furthermore, for the past 60 years, academics have discussed the importance of skills such as oral

	Associate Degree (n=19,000)	Bachelor Degree (n=99,964)	Graduate Degree (n=22,077)
Oral Communication Skills	23%	17%	16%
Written Communication Skills	12%	15%	15%
Collaboration	10%	14%	16%
Problem Solving	10%	13%	11%
Social Intelligence	15%	6%	6%
Communication Skills	8%	9%	9%
Self-Direction	5%	6%	6%
Critical Thinking	4%	6%	5%
Time Management	5%	4%	5%
Ethics	3%	3%	4%
Professionalism	3%	2%	3%
Creativity	1%	2%	2%
Service Oriented	1%	1%	1%
Adaptability	1%	1%	1%
Cultural Sensitivity	0%	0%	0%
Continual Learning	0%	0%	0%

FIGURE 3. 21st-century skill demand by degree level.

and written communication in the ever-changing world and economy (e.g., Bailey, 1953; Horn, 1959). And it has been not just academics discussing these skills but employers both within and outside of the United States. In an international review of skills sought by stakeholders, Billing (2003) analyzed employer surveys dating back to the 1970s from the United Kingdom,

Europe, and the United States and found that although there was some disagreement for collaboration (ranked Number 2 for the United Kingdom and Europe and Number 12 for the United States) and problem solving (ranked numbers 3, 8, and 9 for the United Kingdom, United States, and Europe, respectively), across countries, communication skills ranked either first or

	Arts & Humanities (n=939)	Business (n=18,318)	Education(n=1,765)	Social Sciences (n=2,241)	S.T.E.M. (n=13,105)	Other (n=170)
Oral Communication Skills	16%	17%	16%	17%	16%	20%
Written Communication Skills	15%	15%	15%	18%	14%	16%
Collaboration	15%	12%	16%	18%	16%	14%
Problem Solving	10%	12%	11%	8%	14%	9%
Communication Skills	8%	9%	9%	7%	9%	7%
Self-Direction	8%	7%	5%	5%	6%	10%
Social Intelligence	6%	6%	5%	5%	7%	7%
Critical Thinking	4%	8%	4%	4%	6%	3%
Time Management	5%	5%	4%	4%	4%	3%
Ethics	3%	4%	4%	6%	3%	5%
Creativity	6%	2%	4%	2%	2%	2%
Professionalism	3%	2%	3%	3%	2%	1%
Adaptability	2%	1%	1%	1%	1%	1%
Service Orientation	1%	1%	1%	0%	1%	1%
Continual Learning	0%	0%	0%	0%	1%	1%
Cultural Sensitivity	0%	0%	0%	1%	0%	0%

FIGURE 4. 21st-century skill demand by degree field.

second. Therefore, our findings support decades of research prior to the 21st century by both academics and employers highlighting the importance of these skills for workplace success.

Second, although prior frameworks of 21st-century skills have noted that individuals must possess as many as 17 skills for workplace success (e.g., McCloy et al., 2017), our analysis demonstrated that the average job post specified only 1.69 skills, and

30% stipulated no skills of interest. We hypothesize that this discrepancy stems from the nature of job advertisements in that employers have a limited number of words (depending on the parameters of the job aggregation website) to describe their organization, position being hired, and desired characteristics of a successful applicant. This may put employers in the position of more likely mentioning highly desirable skills that may be uncommon in applicants due to the inability to include



a comprehensive inventory of preferred skills. Therefore, our finding that oral and written communication were the most common co-occurring skills across all jobs, degree fields, and nearly all education levels (minus associate degree-level jobs, which emphasized oral communication and social intelligence) may suggest that these skills are important for workplace success but scarce in the applicant pool. This is supported by a recent survey of 1,000 business executives and hiring managers who indicated that only approximately 40% of recent college graduates possess adequate oral communication skills, even though this is the most in-demand attribute for recent hires (Hart Research Associates, 2018). Similarly, although employers have noted that written communication is critical for workplace success, they have indicated that 47% and 28% of recent 2- and 4-year-degree graduates are deficient in this skill, respectively (Casner-Lotto & Barrington, 2006). These findings suggest that employers perceive a major skills gap (i.e., a skill that is in high demand but in low supply) for both oral and written communication and, as a result, may highlight these skills at a higher rate when advertising positions. Clearly, to close this skills gap, it is vital that the U.S. higher education system adopt learning outcomes standards that emphasize these skills to improve workforce preparedness for college graduates.

### Conclusion

Student development of 21st-century skills is greatly needed to promote workforce preparedness and long-term success of the U.S. economy. To add to the discussion on which skills are of greatest importance for students to develop before entering the workforce, this study investigated skill demand based on direct communication from employers to potential employees via job advertisements. The four most in-demand 21st-century skills found across roughly 142,000 job advertisements were oral and written communication, collaboration, and problem solving. Furthermore, differences in skill demand by education level and degree field were noted. It is our hope that these findings can add to the discussion on developing accountability standards to improve student development of 21st-century skills in the United States.

### NOTES

Joseph Rios is currently an assistant professor at the University of Minnesota, Robert Pugh is now affiliated with Course Hero, and Adam Bacall is no longer employed at the Educational Testing Service. The authors would like to thank Diane Napolitano for her assistance with conceptualizing the data collection procedure and Lin Zhang for his services as the project manager. Furthermore, we are in gratitude to Bobby Naemi for his assistance in providing expert feedback regarding 21st-century skills. In addition, the authors would like to thank Harrison Kell, Diane Napolitano, and Don Powers from the Educational Testing Service for their useful feedback in preparing this manuscript.

The first author conceived of the presented idea. All authors were involved in conceptualizing the data collection process, and the third author wrote the Python code for data extraction. The first three authors conducted data analyses and interpreted the findings. Although the majority of writing was done by the first author, the second and third authors contributed to this work. All authors provided feedback on the draft, and the first and second authors conducted critical revisions of

the article throughout the review process. Final approval of the version to be published was made by all authors.

All authors' contributions to this article were made as work made for hire for the Educational Testing Service.

<sup>1</sup>Defined as the period between December 2007 and January 2010 (Carnevale et al., 2016).

<sup>2</sup>Scrapy documentation was accessed November 2016 from <http://doc.scrapy.org/en/latest/topics/architecture.html>.

<sup>3</sup>Due to the very large sample size examined ( $N = 141,941$ ), statistical tests of percentage differences (i.e., two-sample  $t$  tests between percentages) were not applied due to the high degree of power possessed. Findings in this study were replicated with a data set ( $N = 118,149$ ) collected 1 year after the data reported. Results of the replicated data are presented as supplemental information online (available on the journal website).

### REFERENCES

- References marked with an asterisk denote articles included in the literature review to compile a list of 21st-century skills to be searched for in job advertisements.
- \*Adecco Staffing. (2014). *Mind the skills gap*. <http://pages.adeccousa.com/rs/adeccousa/images/2014-mind-the-skills-gap.pdf>
  - Almlund, M., Duckworth, A. L., Heckman, J. J., & Kautz, T. D. (2011). *Personality psychology and economics* (No. w16822). NBER Working Paper Series. Cambridge, MA: National Bureau of Economic Research.
  - Bailey, W. K. (1953). The importance of communication for advancement in industry. *College Composition and Communication*, 4, 11–13.
  - Billing, D. (2003). Generic cognitive abilities in higher education: An international analysis of skills sought by stakeholders. *Compare: A Journal of Comparative and International Education*, 33, 335–350.
  - Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills. In P. Griffin, B. McGraw, & E. Cane (Eds.), *Assessment and teaching of 21st-century skills* (pp. 17–66). Springer.
  - Burning Glass Technologies. (2015). *The human factor: The hard time employers have finding soft skills*. [http://burning-glass.com/wp-content/uploads/Human\\_Factor\\_Baseline\\_Skills\\_FINAL.pdf](http://burning-glass.com/wp-content/uploads/Human_Factor_Baseline_Skills_FINAL.pdf)
  - \*Burrus, J., Jackson, T., Xi, N., & Steinberg, J. (2013). *Identifying the most important 21st-century workforce competencies: An analysis of the Occupational Information Network (O\*NET)* (ETS RR-13-21). Educational Testing Service.
  - \*Burrus, J., Mattern, K. D., Naemi, B. D., & Roberts, R. D. (2017). Establishing an international standards framework and action research agenda for workplace readiness and success. In J. Golubovich, R. Su & S. B. Robbins (Eds.), *Building better students: Preparation for the workforce* (pp. 303–338). Oxford University Press.
  - Carnevale, A. P., Jayasundera, T., & Gulish, A. (2016). *America's divided recovery: College haves and have nots*. Georgetown University, Center on Education and the Workforce. <https://cew.georgetown.edu/wp-content/uploads/Americas-Divided-Recovery-web.pdf>
  - Carnevale, A. P., Jayasundera, T., & Repnikov, D. (2014). *Understanding online job ads data: A technical report*. Georgetown University, Center on Education and the Workforce.
  - \*Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st-century U.S. workforce*. Partnership for 21st-Century Skills.
  - \*Clark, H., LeFebvre, M., Burkum, K., & Kyte, T. (2013). *Work readiness standards and benchmarks: The key to differentiating America's*

- workforce and regaining global competitiveness. ACT. <http://www.act.org/content/dam/act/unsecured/documents/Work-Readiness-Standards-and-Benchmarks.pdf>
- \*Davies, A., Fidler, D., & Gorbis, M. (2011). *Future work skills 2020*. Institute for the Future for University of Phoenix Research Institute.
- \*De Fruyt, F., Wille, B., & John, O. P. (2015). Employability in the 21st-century: Complex (interactive) problem solving and other essential skills. *Industrial and Organizational Psychology*, 8(2), 276–281.
- Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters: Assessing personal qualities other than cognitive ability for educational purposes. *Educational Researcher*, 44, 237–251.
- Gaff, J. (1981). Reconstructing general education: Lessons from project GEM. *Change: The Magazine of Higher Learning*, 13(6), 52–58.
- Goodman, M. J., Sands, A. M., & Coley, R. J. (2015). *America's skills challenge: Millennials and the future*. Educational Testing Service.
- \*Griffin, P., Care, E., & McGaw, B. (2012). The changing role of education and schools. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of 21st-century skills* (pp. 17–66). Springer.
- \*Hart Research Associates. (2015). *Recent trends in general education design, learning outcomes, and teaching approaches*.
- Hart Research Associates. (2018). *Fulfilling the American dream: Liberal education and the future of work*.
- \*Hogan, R., Chamorro-Premuzic, T., & Kaiser, R. B. (2013). Employability and career success: Bridging the gap between theory and reality. *Industrial and Organizational Psychology*, 6, 3–16.
- Horn, F. H. (1959). Oral communication in a technological world. *Speech Teacher*, 8, 197–203.
- Kirsch, I., Braun, H., Yamamoto, K., & Sum, A. (2007). *America's perfect storm: Three forces changing our nation's future*. Educational Testing Service.
- \*Kyllonen, P. C. (2012, May). *Measurement of 21st-century skills within the Common Core State Standards*. Paper presented at the ETS Invitational Research Symposium on Technology Enhanced Assessments, Princeton, NJ. [https://cerpp.usc.edu/files/2013/11/Kyllonen\\_21st\\_Cent\\_Skills\\_and\\_CCSS.pdf](https://cerpp.usc.edu/files/2013/11/Kyllonen_21st_Cent_Skills_and_CCSS.pdf)
- \*Markle, R., Brennehan, M., Jackson, T., Burrus, J., & Robbins, S. (2013). *Synthesizing frameworks of higher education student learning outcomes (ETS RR-13-22)*. Educational Testing Service.
- \*McCloy, R., Putka, D., Purl, J., Robbins, S., & Le, H. (2017, October). *Identifying universally critical characteristics of O\*NET occupations: A prelude to assessing workforce readiness*. Paper presented at the SIOP Leading Edge Consortium, Atlanta, GA, United States.
- \*National Research Council. (2011). *Assessing 21st-century skills: Summary of a workshop*. National Academies Press.
- \*Neubert, J. C., Mainert, J., Kretzschmar, A., & Greiff, S. (2015). The assessment of 21st-century skills in industrial and organizational psychology: Complex and collaborative problem solving. *Industrial and Organizational Psychology*, 8, 238–268.
- \*Pellegrino, J. W., & Hilton, M. L. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st-century*. National Academy of Sciences.

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