

Article

Soft Skills for Entry-Level Engineers: What Employers Want

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Abstract: Among the requirements for engineering programs, the Accreditation Board of Engineering and Technology (ABET) criteria for student outcomes require students to have the ability to communicate effectively with a range of audiences, recognize ethical and professional responsibilities, function effectively on a team, and apply new knowledge. A review of literature for skills comprised within these ABET criteria determined 26 topics necessary for the entry-level and continued success of engineers. Nearly 500 companies and organizations rated the importance and proficiency of their recent entry-level engineers for these 26 identified soft (professional) skills. The findings suggest that although entry-level engineers have proficiency in all of these ABET required skills, the entry-level engineers were not meeting the level of importance expressed by the organization for 24 of these 26 skills. A specific ABET required skill, the ability to communicate effectively with diverse groups of people, has the greatest difference between the level of proficiency and the level of importance. Analysis of variance was conducted using each of the demographic variables to determine the effect sizes in the ratings of importance, proficiency, and the differences between importance and proficiency. These results were shared with industry members to confirm the relevance of the survey findings during the pandemic. This survey research has implications for any university engineering department where students are seeking entry-level engineering positions after graduation.

Keywords: professional skills; engineering preparation; entry-level expectations; education; soft and hard skills



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1. Introduction

The Accreditation Board of Engineering and Technology [1] identifies preparing students for engineering practice as one of the critical criteria for evaluating engineering education. The expected student outcomes outlined by ABET include non-technical or soft skills such as ability to communicate effectively, function in teams, and the knowledge of the social, political, economic, and global context of their work and the impact of their work in these contexts [2]. Even though ABET articulates the need for engineering education to also support the acquisition of non-technical skills and knowledge, it does not identify a specific set of soft skills on which engineering programs should focus. Because the primary goal of engineering education is to prepare engineers for professional practice, university engineering departments need to turn to industry to understand what soft skills employers want their entry-level engineers (newly hired engineers) to possess and if employers are satisfied with the soft skills these new-hires demonstrate. This study identifies and reports industry assessment of specific soft skills necessary to meet the ABET criteria. The outcomes of the research enable engineering education programs to be responsive to industry needs for non-technical entry-level skill proficiency.

In order to foster the development of program specific skills, engineering curricula place primacy on hard skills (technical skills) over soft skills [3]. The soft skills are not skills or abilities in a traditional sense, but rather they constitute a combination of interpersonal skills and personal attributes [4] that augment the technical skills traditionally seen as paramount to engineering success. There is growing evidence and impetus for focusing intentionally on soft skills within technical and professional curricula [5]. Changes in technology, increasing reliance on automation, transnational production processes, and the sheer complexity of work in the 21st century demand that employees demonstrate skills sets that machines cannot master [6,7]. Workplace situations and interactions that require social and interpersonal skills cannot be automated easily [6]. There are increasing expectations, therefore, for people in technical work places to focus on supplementing and complementing the growing capabilities of machines [3]. Qualities, such as the potential for non-routine interaction, ability to understand people's intentions, actions to successfully collaborate, decision making, leading, and adaptation to a changing environment, give human beings an edge over machines and enable employees to leverage human capabilities that machines cannot successfully master [6–8]. Moreover, there is additional evidence within labor economics, which underscores the need for social, interpersonal, and non-cognitive skills even within professions traditionally deemed technical. Labor economists have established that jobs demanding higher levels of social skills grew more between 1980 and 2012 in contrast to jobs requiring higher math but lower social skills [7]. Furthermore, jobs that will be available for the human workforce in the 21st century and those that will grow and flourish, even within technical fields, demand higher levels of interpersonal and social skills [3].

Concerns related to a lack of soft skills among engineers and engineering graduates have come to the forefront over the last decade. Recognizing the needs of the rapidly evolving and globally dispersed work contexts, IBM (International Business Machines Corporation) recommended that technical education in the 21st century should focus on preparing “T” shaped individuals who are not only steeped in field specific technical knowledge but also are able to demonstrate knowledge across disciplines and the ability to work with others [9]. More recently, in its exploration of the future direction of science, technology, engineering, and mathematics (STEM) education, the STEM connector's Innovation Task Force (SITF) emphasized that the next stage of STEM education should enable students to master the context, which demands the ability to function in teams, to demonstrate business acumen and leadership skills, and to be able to “navigate across global organizations” [10] (p. 13). However, of concern to engineering educators, Busted [11] reported that employers expressed deep concerns about the preparation of college graduates and revealed a great disconnect between what employers expect and the level higher education considered as prepared for work. Another study reported that 58% of managers responding believed that the productivity of their company was limited because of the lack of soft skills among their potential employees, especially among high growth industries and start-up enterprises [12]. Additionally, 59% of these managers specified that employees who demonstrated competence with soft skills were harder to find than those with technical skills [12]. Heckman and Kautz [13] argued that, at an individual level, soft skills such as conscientiousness predicted success in life, academic attainment, health, and higher labor market outcomes as much as cognitive ability. What is more, in a 21st century workplace, lack of soft skills can undermine the technical ability of individuals and can cost them their job and/or potential career growth [14]. Consequently, there is a noteworthy shift in the importance given to soft skills within technical fields. Accrediting bodies, such as ABET, have reiterated the need for engineering education programs to provide students opportunities to acquire a broader set of skills to improve their ability to collaborate, work in teams, and thrive in a globalized work environment [1]. Soft skills that were considered ‘nice to have’ within technical fields in the last century are moving to the ‘need to have’ category in the current century [15–17].

1.1. Purpose and Problem Statement

Soft skills, however, are not a finite set of skills or abilities. They constitute a wide range and disparate set of social and people skills, personal attributes, and self-management skills [18]. Soft skills required by engineers may vary at different levels of their careers [19]. Fundamentally, the set of soft skills required in entry-level occupations are not the same as those necessary for senior management level positions [20]. Recent studies have been conducted to analyze future skills needed and to identify which soft skills employers consider important for new or entry-level engineers [21–26].

The purpose of this study, therefore, was to provide documentation for university engineering programs related to expected soft skills by determining what soft skills employers perceive as being important for entry-level engineers to possess and demonstrate and by assessing the perception of proficiency of recent new hires in engineering. The study also sought to further understand the difference in employers' perceptions about importance and proficiency of soft skills for entry-level engineers within to their performance. A qualitative evaluation of open-ended responses answered the question of what employers look for in applicants and new hires. Snowball unstructured interviews reinforced the outcomes of the quantitative analysis of the survey data and the qualitative evaluation of open-ended responses. The objective was to inform engineering educators about the need to focus on non-technical skills within the curriculum [1,27] and help to prioritize which soft skills are reported as most important for entry-level engineering roles.

1.2. Research Questions

This study addressed the following research questions:

- What soft skills do employers expect entry-level engineers to demonstrate, which soft skills are most important?
- What is the perception of employers regarding the general level of soft skills proficiency of entry-level engineers?
- What is the difference between expectations of employers and their perceptions of proficiency demonstrated by entry-level engineers across the measured set of soft skills?
- What are the qualities that employers look for in applicants and new hires as entry-level engineers?

1.3. Conceptual Framework

ABET expects engineering programs to reflect current and future aspects of the technical fields and prepare students for a career in the discipline. Engineering programs are required to watch the trends in technical fields and the changes in knowledge and skill requirements these changes might augur. Environmental scanning is an established process used by organizations and higher educational institutions to gather information on the current and future trends in the macroenvironment in which they operate [28]. Aguilar (as cited in [28]) identified four methods of scanning the macroenvironment, including formal searching that refers to proactive seeking of information for specific purposes. The goal of environmental scanning is to alert decision makers to changes in the environment that lead to, or might lead to, changes in expectations [28]. In this study we use environmental scanning as the conceptual framework to assess the expectations of employers that recruit engineering graduates with the purpose of using the outcomes to inform engineering education programs. We specifically used an active, formal search approach to gather data on what soft skills employers expected engineering graduates to possess.

2. Review of Literature

2.1. What Are Soft Skills?

Skills generally refer to abilities people have acquired over time with effort or training and always involve an element of execution or performance [17,18]. Hard skills in an engineering context refer to technical skills or abilities that are required to perform work

related tasks. Soft skills on the other hand are less tangible, hard to quantify, and rather challenging to define. In contrast to technical knowledge or abilities, the term 'soft skills' is used loosely in literature to denote a disparate set of personal attributes, traits, attitudes, and behaviors [4,17].

Research on soft skills exists across different fields such as labor economics [7]; employability, workforce development, and human resource development [6,8]; management and communication [4,29]; and in industry or subject specific literature such as information technology [20,30]; STEM [31]; education [15], or library and information science [18]. In addition, not for profit agencies and government funded or public sector projects also conduct country, region, or industry specific research on soft skills [32–34]. Private consulting agencies involved in studying the pulse of specific industries and evolving skill requirements within these industries investigate non-technical skills alongside technical skills requirements [11]. Given the multiplicity of fields in which research on soft skills is situated, it is not surprising that the taxonomy of soft skills is varied or that the definition of the term is rather fuzzy.

There is no universally accepted classification of what constitutes a soft skill [17,18]. Researchers use terms such as non-cognitive, non-technical skills; people skills; transferable skills; employability skills; and interpersonal skills to refer to soft skills [17,18,27]. Most research equates soft skills with people skills or the ability to get along with or work effectively with others [4]. However, soft skills are more than people skills or interpersonal skills (such as effective communication, collaboration, and co-operation) required to relate to other people [4,17,18]. The term soft skills also encompasses intrapersonal elements (abilities such as adaptability and self-regulation that reside within the individual), personality traits (example: agreeableness, conscientiousness), attributes (example: confidence, resilience); and straddles both the cognitive (examples: analytical ability, decision-making) and affective (example: active listening, empathy) domains [17,18]. Since soft skills are non-technical and not industry specific, these are highly transferable across contexts and are broadly applicable [35].

2.2. Research on Soft Skills

Research on soft skills generally tends to focus on: (a) examining the importance of soft skills in academic and work contexts; (b) compiling a list of soft skills that employers consider important in a specific field; (c) comparing perceptions of different stakeholders on the importance of a specific set of soft skills within a given field or industry; (d) assessing soft skills requirements for different levels of employment; and (e) developing tools to measure soft skills or assess their demonstration. For instance, Heckman and Kautz [36] demonstrated that personality traits such as conscientiousness, perseverance, sociability, and curiosity played a significant role in predicting and determining success in academic, social, and work lives. Exploring the importance of soft skills from the demand perspective, Deming [7] found that jobs requiring high social interactions experienced significant growth in the United States between 1980 and 2012. Several studies have also emphasized a demand for social and interpersonal skills in the labor market in the coming years [6,36–39].

There exists a robust portfolio of research on the soft skills required in specific industries. Robles [4] asked business executives to identify ten soft skills they considered most important for new employees to possess and collected a list of 517 soft skills. Robles [4] then identified the top ten most frequently listed soft skills and created a questionnaire asking the executives to rank these skills in order of importance. Adopting a quasi-ethnographic approach Windels, Mallia, and Broyles [40] explored specific soft skills that were most useful in the advertising industry. Research on skills requirements in the field of library and information science also explored soft skills essential to succeed in the evolving field [41,42].

Comparing perceptions of various stakeholders such as students (for example: [5]), faculty, and employers on soft skills requirements is another area of emphasis within soft skills research. Rainsbury, Hodges, Burchell, and Lay [43] studied the perceptions of

students and graduates on workplace competencies. More recently, using a qualitative approach John and Chen [31] investigated the importance placed by students and industry practitioners on the skills (both technical and non-technical) necessary for success in STEM. In their study of knowledge and skill requirements (including interpersonal skills and personal traits) for entry-level information technology workers, Aasheim et al., [30] compared the perspectives of industry personnel and faculty.

Determining soft skills requirements for different categories of employees such as entry-level performers, middle management, and senior management or leadership is also gaining traction in different fields. For instance, Weber, Finley, Crawford, and Rivera [44] studied soft skills required for entry-level managers in the hospitality and tourism industry. Another study used the Delphi method to identify skills for success at various stages of careers within the information technology (IT) industry [19]. The study developed a list of skills including non-technical, interpersonal, and intrapersonal skills IT professionals considered most important for success at entry-level, mid-managerial level, and senior managerial level within their industry [20].

Assessment of these intangible skills is another challenge explored in soft skills research. Klein, DeRouin, and Salas [45] provided a taxonomy of interpersonal skills and suggested a variety of means to categorize and assess interpersonal skills. Loughry, Ohland, and Moore [46] focused specifically on individuals' ability to work in teams and demonstrated means to assess capacity for working effectively in teams. Some researchers have developed scales or tools to measure specific soft skills. For instance, Taggar and Brown [47] created scales to measure conflict resolution, communication, and group problem solving. Heckman and Kautz [13] not only argued that personality traits played a significant role in predicting and determining success in academic, social, and work lives beyond standardized achievement tests, but also demonstrated how personality traits can be measured.

2.3. What Soft Skills Are Important in the Employment Context?

In an attempt to understand the demand side of conditions, researchers and research groups often compile a list of soft skills based on employer expectations or requirements. They collect data from employers through surveys and interviews on soft skills they want their employees to possess or demonstrate. Table 1 presents lists of soft skills required for entry and success in the workplace. The references presented are organized by date. The citation counts provided offer support for the continued relevance of the lists of soft skills.

Table 1. Lists of Soft Skills Required for Entry and Success in the Workplace.

Author/Source	Area of Focus	Source of Data	List of Soft Skills Considered Important
Andrews and Higson, 2008 [48] (over 1200 citations)	Graduate employment	Literature review	Professionalism, reliability, ability to cope with uncertainty, ability to work under pressure, ability to plan and think strategically, capability to communicate and interact with others either in team or through networking, good written and verbal communication skills, creativity and self-confidence, good self-management and time management skills, willingness to learn and accept responsibility

Table 1. Cont.

Author/Source	Area of Focus	Source of Data	List of Soft Skills Considered Important
Aasheim, Li, and Williams, 2009 [30] (over 140 citations)	Information technology (entry-level)	Senior and middle management	Communication, ability to work in teams, interpersonal skills, personal skills or traits, honesty/integrity, analytical skills, flexibility/adaptability, motivation, creative thinking, organizational skills, entrepreneurial skills/risk-taking
Mitchell, Skinner, and White, 2010 [49] (over 350 citations)	Business graduates	Recruiters	Positive attitude, being respectful, trustworthy, honest and ethical, taking initiative and responsibility, being co-operative and a team player, possessing good communication and interpersonal skills, being ambitious and self-confident, and ability to think critically
Crawford, Lang, Fink, Dalton, and Fielitz, 2011 [32]	Students graduating from agriculture and natural resources related programs	Employers Alum, Faculty, Students	Seven soft skills clusters: communication, decision-making/problem-solving, self-management, team work, professionalism
21st century skills for engineers (Hanover, 2011) [33]	Engineers		Team work, consensus building, entrepreneurial mindset, creative design, empathy and social responsibility, global awareness and perspective, ethical behavior and trustworthiness, broad systems thinking, multidisciplinary thinking
Robles, 2012 [4] (over 1600 citations)	Business graduates	Business Executives	Communication, courtesy, flexibility, integrity, interpersonal skills, positive attitude, professionalism, responsibility, team work, work ethic
Lippman, Ryberg, Carney, and Moore, 2015 [50] (over 200 citations)	Youth	Literature review	Social skills, communication skills, higher order thinking skills, self-control, positive self-concept
Wikle and Fagin, 2015 [51] (over 50 citations)	Geographic Information Science	Employer	Problem solving/trouble shooting, critical thinking, flexibility/adaptability, working in a team environment/ability to work independently, time management/multi-tasking, creativity/verbal presentation, writing, project management/leadership

Table 1. Cont.

Author/Source	Area of Focus	Source of Data	List of Soft Skills Considered Important
Berger, 2016 [12] (over 5 citations)	Entry-level contributors	LinkedIn profiles	Communication, organization, team work, creativity, social skills, critical thinking, interpersonal communication, adaptability, punctuality, friendly personality
John and Chen, 2017 [31] (over 2 citations)	STEM	Employer	Team work, communication, empathy, analytical skills, self-control, positive self-concept
Pócssová, Bednárová, Bogdanovská, and Mojžišová, 2020 [27] (over 2 citations)	Engineers	Social and emotional learning competencies	Critical thinking/problem solving, creativity, communication skills, collaboration
Fernandes, Jardim, and Lopes, 2021 [15] (over 5 citations)	Special education teachers	Literature review	Personal and social skills, personal attributes management, performance improvement, sustaining interpersonal relationships

Close analysis of the soft skills required across different studies (Table 1) establishes a lack of uniformity in the set of soft skills required within different disciplines or industries. Moreover, very few studies specifically focus on soft skills requirements for employees at one or different levels of employment. Soft skills required at entry-level employment may be different from those that are required at middle managerial or senior management levels [18,20,30]. In addition, soft skills required to survive, grow, and contribute effectively in technical professions differ from those that apply to generic college level employment. Whatever literature that is available on soft skills requirements for engineers is either broad-based and not employment level specific or it is a compilation of expert opinion. There is a dearth of evidence-based studies that attempt to identify soft skills required by entry-level engineers specifically [52]. This study endeavors to address this gap in literature by compiling a set of soft skills for employers to evaluate for the level of importance for engineers who are recently out of college to possess. Second, the study documents perceptions of employers about the level of proficiency newly hired engineers demonstrate in these important soft skills. Documenting the soft skills employers expect can help engineering educators target specific skills and strategies when preparing the engineering workforce. Understanding employers' perceptions about general proficiency levels of engineering graduates in terms of soft skills enables prioritization of areas that engineering educators need to concentrate on within their mainstream curriculum and through supplemental activities.

3. Method and Results

The study employed a survey to collect data from employers who hired newly graduated engineers. The study sought to find: (a) the set of soft skills employers expect from their entry-level/new hire engineers; and (b) employers' rating of the proficiency levels of entry-level engineers in terms of soft skills. The survey was conducted prior to the pandemic. The results of the analysis of variance were shared using a snowball interview technique with engineers, educators, and managers in industries identified as having statistically significant results. These follow-up interviews to confirm or refute the findings of the analysis were conducted in summer and fall 2021.

The comparison of importance and proficiency is a job analysis type method where the use of the two indicators, importance and proficiency, relate to research to assess functions and effectiveness of characteristics of employees [53]. Importance and proficiency are used

to measure the scope and range of responsibilities for positions. The measure of importance provides an indicator of the job requirements and the differences, importance minus proficiency, provide the strengths and development needs of those being rated. Responses about the importance of skills and the perception of performance clarify the engineer's roles and job requirements, identify individual engineer's strengths and development needs, inform education planning needs, support decisions about engineering programs, confirm training and development priorities and resource allocation, identify content and design of engineering training and development programs, and supply evaluation data for engineering training and development programs.

3.1. Survey Design and Distribution

The survey was created based on extensive review of soft skills literature that reported employer expectations in the following categories: (a) graduate employment; (b) STEM and technical professions; (c) future skills requirements in STEM; (d) entry-level employees; and (e) youth employability. Initially the researchers combed literature on soft skills to arrive at the taxonomy of soft skills and the different terms used to refer to soft skills across disciplines. Then we identified literature that reported employer expectations or requirements or perceptions of soft skills (or terms used interchangeably such as transferable skills, employability skills, interpersonal skills, non-technical or non-cognitive skills) in each of the categories. We then compiled a set of soft skills across the literature collected, and, lastly, assembled a set of 26 soft skills that appeared most frequently across these categories. The list of 26 soft skills compiled from literature formed the crux of the survey created. The survey itself consisted of four sections of questions (see Table 2) followed by space at the end for participants to add their comments and inputs regarding soft skills requirements for entry-level engineers. Career service professionals who work closely with engineering employers and senior academicians vetted the survey for content and language and then the survey was pilot tested with 10 engineering employers. The researchers then incorporated the suggestions collected in the process and finalized the survey for distribution. The survey was distributed to 1200 employers who were known to employ engineers through Qualtrics and over a period of 30 days in 2018; we received 489 responses (40.75%).

Table 2. Survey Format.

Survey Sections	Focus
Section A	Profile details of respondents and the organization represented (job title, supervisory responsibilities over entry-level engineers, organization details: size, sector, headquarters, nature of business)
Section B	List of 26 soft skills (level of importance of each of these skills)
Section C	List of 26 soft skills (rating of proficiency levels of entry-level engineers in their organization on each of these skills)
Section D	Types of engineers employed in their organization (example: mechanical engineer; software engineers; process engineers)
Section E	Space to add inputs and comments on soft skills requirements for entry-level engineers

Information about the Respondents and Their Organizations

Respondents to the survey were asked questions about their organization. A summary of these questions and frequencies are presented in Table 3. Firm size was reported in categories of less than 100, 100 to 500, and more than 500. Categorization of the organizations were to indicate if the organization was in the private sector, public sector, or other. Open ended responses for the other types of organizations included education, government contract, military contract, non-profit, research, and utility. To assess the geographical

boundaries of the organizations, respondents indicated if their organization was headquartered in or outside the United States and if the organization had branches, offices, or plants outside the United States. Respondents were asked an open-ended question to state the primary line of business for their organization. The result was over 240 individual responses. A recode of these responses reduced the number of primary lines of business to 20 industries and a category of not declared. Over 300 different titles were entered by the respondents in response to the open-ended question prompt asking for the respondent's current title. These titles were recoded into six position titles: administrator, director, engineer, HR, manager, and recruiter. Those without an entry were coded as not declared. The last profile question asked if the respondent supervised entry-level engineers directly.

Table 3. Profile of the Respondents and their Organizations.

Category	Response Options	Frequency	Valid Percent (%)
Number of people employed in organization	Less than 100	96	22.0
	100–500	95	21.7
	More than 500	246	56.3
Categorization of the organization	Private Sector	317	72.5
	Public Sector	105	24.0
	Other	15	3.4
Headquarters in the United States	Yes	388	88.8
	No	49	11.2
Organization has branches, offices, or plants outside the United States	Yes	304	69.6
	No	133	30.4
Primary line of business	Aerospace	20	4.1
	Automotive	16	3.3
	Chemical	6	1.2
	Civil Engineering	11	2.3
	Consumer Products	32	6.6
	Defense	11	2.3
	Education	6	1.2
	Electronics	7	1.4
	Energy	5	1.0
	Engineering	31	6.4
	Financial	6	1.2
	Healthcare	4	0.8
	Industrial Engineering	7	1.4
	Manufacturing	131	26.9
	Medical	24	4.9
	Not declared	53	10.9
	R&D	8	1.6
	Semiconductor	14	2.9
	Technology	79	16.2
	Transportation	4	0.8
Utilities	12	2.5	

Table 3. Cont.

Category	Response Options	Frequency	Valid Percent (%)
Current title of respondent within organization	Administrator	16	3.3
	Director	87	17.9
	Engineer	120	24.6
	HR	55	11.3
	Manager	113	23.2
	Not declared	52	10.7
	Recruiter	44	9.0
Respondent directly supervises entry-level engineers	Yes	217	49.8
	No	219	50.2

Note: N = 487. Missing values are not included in the table.

3.2. Results of Paired Mean Difference Analysis

The 26 soft skills were evaluated using a Likert scale of 0 as not important or not proficient to 4 as absolutely essential or absolutely proficient. A paired *t*-test was conducted to examine the mean of paired differences between each respondent's rating of importance and proficiency because it was determined that the responses were not independent of each other [54]. The mean of the paired differences resulted in 24 of the 26 soft skills assessed as having a statistically significant difference of the two ratings. The level of importance exceeded the level of proficiency for these 24 soft skills. Figure 1 depicts the comparison of the levels of importance and the levels of proficiency for each of the soft skills; the entries are presented in rank order from greatest to least of the means of the paired difference values. Table 4 is presented based upon the ranking for the level of proficiency and depicts the mean value for each of the soft skills and the mean of the paired differences.

The five soft skills rated as most important for an entry-level engineer were: (1) reliability, (2) ability to work in teams, (3) responsibility, (4) self-motivation, and (5) positive attitude. The five soft skills rated to have the greatest differences between the paired ratings of importance and proficiency were: (1) the ability to communicate with diverse groups of people, (2) time management, (3) ability to write effectively, (4) the ability to deal with uncertainty when relating to people and situations, and (5) the ability to communicate across age groups. The five skills with the least proficiency and with a statistically significant difference for the paired *t*-test were: (1) leadership, (2) the ability to deliver effective presentations, (3) the ability to plan and think strategically, (4) the ability to write effectively, and (5) the ability to deal with uncertainty when relating to people and situations.

Results of Analysis of Variance of Differences by Profile Characteristic

A new variable was calculated within the data set to have a difference in ratings value for each of the 26 soft skills rated by the respondents for their importance within their organization and proficiency displayed by the organization's newly hired engineers. This difference rating was calculated with the importance minus the proficiency. Outcomes of this calculation for individuals in similar assessment are used in job analyses to determine needs for training, coaching, or other professional development. Analyzed using analysis of variance for each of the profile variables, the outcomes can be used to identify where there is a need for additional development of engineers prior to being hired, and where educational programs could further assess their curricula to support development of the soft skills identified. A large positive difference indicates the ratings for importance were greater than the ratings of proficiency of the newly hired engineers. Differences at or near zero indicate the ratings for importance and for proficiency were the same or close to each other, respectively, and it is likely the educational preparation of the newly hired engineers is sufficient to meet the organizations needs and requirements.

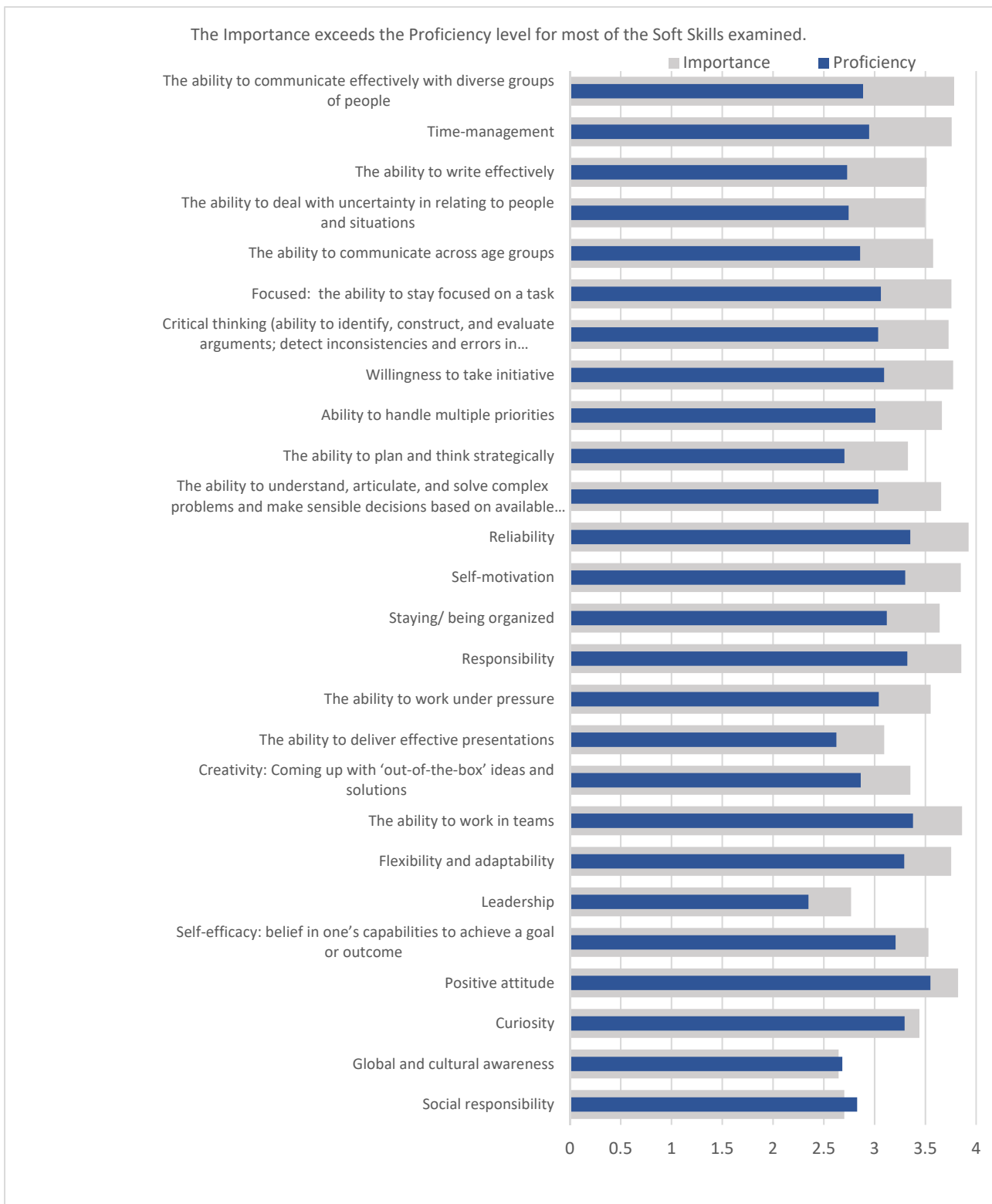


Figure 1. Importance vs. Perceived Proficiency.

Table 4. Soft skills rating of importance and proficiency and pair differences means, ranked by proficiency rating from least to greatest.

Soft Skills	Importance	Proficiency	Paired Differences Mean	
Leadership	2.77	2.35	0.41	***
The ability to deliver effective presentations	3.10	2.62	0.50	***
Global and cultural awareness	2.65	2.68	−0.03	
The ability to plan and think strategically	3.33	2.70	0.62	***
The ability to write effectively	3.51	2.73	0.80	***
The ability to deal with uncertainty in relating to people and situations	3.50	2.75	0.79	***
Social responsibility	2.70	2.83	−0.10	
The ability to communicate across age groups	3.58	2.86	0.73	***
Creativity: coming up with ‘out-of-the-box’ ideas and solutions	3.35	2.86	0.49	***
The ability to communicate effectively with diverse groups of people	3.78	2.89	0.90	***
Time-management	3.76	2.95	0.82	***
Ability to handle multiple priorities	3.66	3.01	0.65	***
Critical thinking (ability to identify, construct, and evaluate arguments; detect inconsistencies and errors in reasoning; solve problems systematically; reflect on underlying values and beliefs)	3.73	3.04	0.70	***
The ability to understand, articulate, and solve complex problems and make sensible decisions based on available information	3.66	3.04	0.62	***
The ability to work under pressure	3.55	3.04	0.52	***
Focused: the ability to stay focused on a task	3.76	3.06	0.71	***
Willingness to take initiative	3.77	3.09	0.70	***
Staying/ being organized	3.64	3.12	0.54	***
Self-efficacy: belief in one’s capabilities to achieve a goal or outcome	3.53	3.21	0.36	***
Flexibility and adaptability	3.75	3.29	0.48	***
Curiosity	3.44	3.30	0.13	*
Self-motivation	3.85	3.30	0.55	***
Responsibility	3.86	3.32	0.52	***
Reliability	3.93	3.35	0.57	***
The ability to work in teams	3.86	3.38	0.48	***
Positive attitude	3.82	3.55	0.28	***

Note: * $p < 0.05$, ***: $p \leq 0.001$.

Analysis of variance was conducted to determine if any of the profile characteristics resulted in between group differences for the new variable calculated using importance rating minus proficiency rating. Results of the ANOVAs are presented with the partial eta squared effect size and Cohen’s F effect size [55] for comparisons that were statistically significant between the organization or respondent profile attributes; Partial eta squared effect sizes are considered small 0.01, medium 0.06, large 0.14, and Cohen’s F effect sizes are considered small 0.1, medium 0.25, large 0.4.

Size of the Organization. When considering the size of the organization (less than 100, 100–500, more than 500), statistically significant differences were determined for the difference in ratings of *the ability to communicate across age groups* ($\bar{x}_{<100} = 0.57$, $sd = 1.23$; $\bar{x}_{100-500} = 0.56$, $sd = 0.79$, $\bar{x}_{>500} = 0.87$, $sd = 0.92$, $F = 4.25$, $p = 0.015$, $\eta^2 = 0.025$, Cohen’s F = 0.16) and *the ability to deliver effective presentations* ($\bar{x}_{<100} = 0.32$, $sd = 1.12$; $\bar{x}_{100-500} = 0.29$, $sd = 0.96$, $\bar{x}_{>500} = 0.66$, $sd = 1.09$, $F = 4.59$, $p = 0.011$, $\eta^2 = 0.027$, Cohen’s F = 0.17). The Tukey pairwise compari-

son indicated for the difference in ratings of *the ability to communicate across groups*, the ratings for respondents in companies with more than 500 employees were higher than the ratings by respondents in companies with 100–500 employees (*mean difference* = 0.31, *Std Error* = 0.13, $p = 0.046$). The Tukey pairwise comparison for *the ability to deliver effective presentations* indicated that the ratings for respondents in companies with more than 500 employees were higher than the ratings for respondents in companies with 100–500 employees (*mean difference* = 0.37, *std error* = 0.14, $p = 0.028$). The effect size for each of these questions is a small to medium effect as indicated by the eta squared effect size and the Cohen's F effect size.

Sector Type of Organization. Respondents identified their organization as being categorized as public sector, private sector, or other. Statistically significant differences in the ratings between these three groups were found for only one of the differences in soft skills ratings. Tukey pairwise comparisons of the ratings for *willingness to take initiative* ($\bar{x}_{private} = 0.67$, $sd = 0.90$; $\bar{x}_{public} = 0.91$, $sd = 1.10$, $\bar{x}_{other} = 0.07$, $sd = 0.92$, $F = 5.04$, $p = 0.007$, $\eta^2 = 0.029$, *Cohen's F* = 0.17) indicated differences between the public sector and those who indicated other (*mean difference* = 0.84, *std error* = 0.28 $p = 0.007$). The effect sizes for this difference between public sector organizations and other types of organizations is a small to medium effect.

Geographic Location of Headquarters and Branches, Offices, of Plants. Ratings for differences of importance and proficiency of newly hired engineers for organizations that reported headquarters in the United States did not differ statistically when compared to those with headquarters in other countries. Statistically significant differences were found when conducting an ANOVA of differences in the ratings of importance and proficiency categorized by respondents' indication if the organization had branches, offices, or plants outside the United States. Between group statistically significant differences were found for *the ability to communicate across age groups* ($\bar{x}_{yes} = 0.81$, $sd = 0.91$; $\bar{x}_{no} = 0.55$, $sd = 1.09$, $F = 5.10$, $p = 0.025$, $\eta^2 = 0.015$, *Cohen's F* = 0.12), *the ability to deliver effective presentations* ($\bar{x}_{yes} = 0.59$, $sd = 1.09$; $\bar{x}_{no} = 0.29$, $sd = 1.02$, $F = 5.62$, $p = 0.018$, $\eta^2 = 0.016$, *Cohen's F* = 0.13), and *global and cultural awareness* ($\bar{x}_{yes} = 0.07$, $sd = 1.14$; $\bar{x}_{no} = 0.27$, $sd = 1.27$, $F = 6.04$, $p = 0.015$, $\eta^2 = 0.018$, *Cohen's F* = 0.14). Each of these effect sizes are small.

Primary Line of Business. After recoding the open-ended responses for the primary line of business indicated by the respondent, the ANOVA to examine between industry differences of the differences in ratings for importance and proficiency of newly hired engineers resulted in one of the differences to be statistically significant ($F = 2.16$, $p = 0.004$, $\eta^2 = 0.11$, *Cohen's F* = 0.36). Tukey pairwise comparisons were conducted to identify for which industry type differences were statistically significant for *the ability to write effectively* for five of the between group comparisons. These outcomes are presented in Table 5. The negative value for the mean of the differences of the ratings the respondents who identified as being in an organization whose primary line of business was healthcare indicates that these respondents on average rated the level of proficiency of their newly hired engineers higher than the importance of *the ability to write effectively*. The effect sizes for this statistically significant difference in ratings is medium to large.

Table 5. Primary Line of Business Recode Between Variable Tukey Pairwise Results.

Business Recode (I)	N (I)	\bar{x} (I)	<i>sd</i> (I)	Business Recode (J)	N (J)	\bar{x} (J)	<i>sd</i> (j)	MD (I–J)	SE	Sig
Defense	9	1.33	1.12	Healthcare	4	−1.0	2.0	2.33	0.64	0.043
Energy	5	1.60	0.55	Healthcare	4	−1.0	2.0	2.60	0.71	0.035
Engineering	23	1.22	1.13	Healthcare	4	−1.0	2.0	2.22	0.55	0.029
Medical	16	1.31	0.87	Healthcare	4	−1.0	2.0	2.31	0.61	0.023
R&D	4	1.75	1.26	Healthcare	4	−1.0	2.0	2.75	0.73	0.030

Note: MD: mean difference; SE: standard error, Sig.: significance, p .

Role of Respondent in Organization. The open-ended response for respondents to enter their current title in their organization was recoded from over 300 entries to 6 titles and a not declared category. The not declared entries included missing data in the ratings of importance or proficiency and were all removed from the analysis through pairwise deletion of the entry during analysis. An ANOVA was conducted for the remaining 338 entries. Statistically significant differences were noted for four of the ratings' differences calculated by subtracting the proficiency rating of newly hired engineers from the rating of importance. The four soft skills were *ability to communicate effectively with diverse groups of people* ($F = 2.56, p = 0.027, \eta^2 = 0.037, \text{Cohen's } F = 0.19$), *critical thinking (ability to identify, construct, and evaluate arguments; detect inconsistencies and errors in reasoning; solve problems systematically; reflect on underlying values and beliefs)* ($F = 2.35, p = 0.041, \eta^2 = 0.034, \text{Cohen's } F = 0.19$), *time-management* ($F = 2.46, p = 0.033, \eta^2 = 0.036, \text{Cohen's } F = 0.19$), and *self-motivation* ($F = 3.08, p = 0.010, \eta^2 = 0.044, \text{Cohen's } F = 0.21$). The effect sizes for these differences are small to medium effects. The means, standard deviations, mean differences, standard errors, and significance levels are presented in Table 6.

Table 6. Role of Respondent in Organization Recode Between Variable Tukey Pairwise Results.

Soft Skill										
Position Recode (I)	N (I)	\bar{x} (I)	sd (I)	Position Recode (J)	N (J)	\bar{x} (J)	sd (j)	MD (I–J)	SE	Sig
<i>Ability to communicate effectively with diverse groups of people</i>										
Engineer	95	1.06	0.98	Recruiter	27	0.41	0.50	0.66	0.20	0.012
<i>Critical thinking (ability to identify, construct, and evaluate arguments; detect inconsistencies and errors in reasoning; solve problems systematically; reflect on underlying values and beliefs)</i>										
Engineer	95	0.86	0.92	Recruiter	27	0.22	0.58	0.64	0.20	0.018
<i>Time-management</i>										
Engineer	95	0.93	1.00	Recruiter	27	0.26	0.66	0.67	0.20	0.014
Manager	93	0.91	0.89	Recruiter	27	0.26	0.66	0.65	0.20	0.018
<i>Self-motivation</i>										
Director	70	0.74	0.81	Recruiter	27	0.04	0.59	0.71	0.19	0.004
Manager	93	0.61	0.88	Recruiter	27	0.04	0.59	0.58	0.19	0.025

Note: MD: mean difference; SE: standard error, Sig.: significance, p .

Supervision Role by Respondents in Organization. Respondents indicated in the profile questions if they had direct supervision requirements for newly hired engineers. Analysis of this response on the differences of the ratings indicated that 11 of the 26 soft skills had statistically significant differences when comparing those who had direct supervision of newly hired engineers ($N = 180$) and those who did not ($N = 158$). The differences were found for *ability to communicate effectively with diverse groups of people* ($\bar{x}_{yes} = 1.01, sd = 0.96; \bar{x}_{no} = 0.78, sd = 0.84, F = 5.56, p = 0.019, \eta^2 = 0.016, \text{Cohen's } F = 0.13$), *ability to deliver effective presentations* ($\bar{x}_{yes} = 0.64, sd = 1.08; \bar{x}_{no} = 0.34, sd = 1.06, F = 6.48, p = 0.011, \eta^2 = 0.019, \text{Cohen's } F = 0.14$), *ability to write effectively* ($\bar{x}_{yes} = 0.93, sd = 1.00; \bar{x}_{no} = 0.55, sd = 0.97, F = 6.86, p = 0.009, \eta^2 = 0.020, \text{Cohen's } F = 0.14$), *ability to understand, articulate, and solve complex problems and make sensible decisions based on available information* ($\bar{x}_{yes} = 0.79, sd = 1.01; \bar{x}_{no} = 0.42, sd = 0.80, F = 13.85, p < 0.001, \eta^2 = 0.040, \text{Cohen's } F = 0.20$), *critical thinking* ($\bar{x}_{yes} = 0.83, sd = 1.01; \bar{x}_{no} = 0.56, sd = 0.79, F = 7.05, p = 0.008, \eta^2 = 0.021, \text{Cohen's } F = 0.15$), *self-efficacy: belief in one's capabilities to achieve a goal or outcome* ($\bar{x}_{yes} = 0.49, sd = 1.05; \bar{x}_{no} = 0.21, sd = 0.96, F = 6.68, p = 0.010, \eta^2 = 0.019, \text{Cohen's } F = 0.14$), *staying/being organized* ($\bar{x}_{yes} = 0.65, sd = 1.01; \bar{x}_{no} = 0.41, sd = 0.84, F = 5.75, p = 0.017, \eta^2 = 0.017, \text{Cohen's } F = 0.13$), *time-management* ($\bar{x}_{yes} = 0.96, sd = 0.94; \bar{x}_{no} = 0.66, sd = 0.92, F = 8.94, p = 0.003, \eta^2 = 0.026, \text{Cohen's } F = 0.16$), *self-motivation*—($\bar{x}_{yes} = 0.68, sd = 0.95; \bar{x}_{no} = 0.40, sd = 0.72, F = 9.05, p = 0.003, \eta^2 = 0.026$,

Cohen's $F = 0.16$), *responsibility*—($\bar{x}_{yes} = 0.86$, $sd = 0.93$; $\bar{x}_{no} = 0.42$, $sd = 0.76$, $F = 4.03$, $p = 0.045$, $\eta^2 = 0.012$, Cohen's $F = 0.11$), and *ability to handle multiple priorities* ($\bar{x}_{yes} = 0.79$, $sd = 1.04$; $\bar{x}_{no} = 0.49$, $sd = 0.87$, $F = 8.31$, $p = 0.004$, $\eta^2 = 0.024$, Cohen's $F = 0.16$). The effect sizes for each of these differences are small to medium effects.

3.3. Results of between Organization and Respondent Characteristics Analysis of Variance of Importance and Proficiency Ratings

The ratings were further analyzed to determine if there were differences in ratings of importance and proficiency related to the profiles of the organization and the respondents. The analysis was motivated by several of the analyses of the differences in the ratings such as the role of the respondent where the respondents identified as recruiters has ratings that were closer to each other than three of the other coded roles in the organization. The differences noted in this section for the level of importance will reinforce the topics that should be included within the engineering curriculum as needed for preparation for specific industries. The differences identified for proficiency can be used to inform where engineer programs would consider additional opportunities to practice the soft skills reported to be areas where prior newly hired engineers were not as proficient as others hired in different categories of organizations.

3.3.1. Results of Organizations' Size Analysis of Variance

Respondents indicated the size of their organization as either less than 100, 100 to 500, or more than 500 employees. Between group comparisons were completed for the ratings of importance and the ratings of proficiency of newly hired engineers for the organization size. Tukey pairwise comparisons were determined for any statistically significant between group differences.

The analysis of variance to examine the between group differences for importance ratings noted three soft skills with statistically different differences: the *ability to deliver effective presentations* ($\bar{x}_{<100} = 2.71$, $sd = 1.00$; $\bar{x}_{100-500} = 3.06$, $sd = 1.02$, $\bar{x}_{>500} = 3.25$, $sd = 0.87$, $F = 10.16$, $p < 0.001$, $\eta^2 = 0.048$, Cohen's $F = 0.22$) *ability to work in teams* ($\bar{x}_{<100} = 3.74$, $sd = 0.66$; $\bar{x}_{100-500} = 3.88$, $sd = 0.39$, $\bar{x}_{>500} = 3.90$, $sd = 0.34$, $F = 4.21$, $p = 0.013$, $\eta^2 = 0.021$, Cohen's $F = 0.15$), and *leadership* ($\bar{x}_{<100} = 2.51$, $sd = 1.00$; $\bar{x}_{100-500} = 2.81$, $sd = 1.08$, $\bar{x}_{>500} = 2.85$, $sd = 0.95$, $F = 4.42$, $p = 0.013$, $\eta^2 = 0.021$, Cohen's $F = 0.15$). Tukey pairwise comparisons noted that for ratings of the importance of *ability to deliver effective presentations*, organizations with 100–500 employees were rated higher than organizations with less than 100 employees (*mean difference* = 0.34, *std error* = 0.14, $p = 0.044$) and organizations with more than 500 employees were rated higher than organizations with less than 100 employees (*mean difference* = 0.53, *std error* = 0.12, $p < 0.001$). Tukey pairwise comparisons noted that for ratings of the importance of *ability to work in teams*, organizations with more than 500 employees were rated higher than organizations with less than 100 employees (*mean difference* = 0.16, *std error* = 0.06, $p = 0.009$). Tukey pairwise comparisons noted that for ratings of the importance of *leadership*, organizations with more than 500 employees were rated higher than organizations with less than 100 employees (*mean difference* = 0.33, *std error* = 0.13, $p = 0.002$). The effect sizes for each of these differences are small to medium effects.

The analysis of variance to explore the responses for differences in the ratings for proficiency of newly hired engineers resulted in one statistically significant difference in proficiency ratings by respondents, *leadership* ($\bar{x}_{<100} = 2.11$, $sd = 0.90$; $\bar{x}_{100-500} = 2.27$, $sd = 1.02$, $\bar{x}_{>500} = 2.48$, $sd = 0.95$, $F = 4.23$, $p = 0.015$, $\eta^2 = 0.025$, Cohen's $F = 0.16$), Tukey pairwise comparisons noted that for ratings of the proficiency of *leadership* by newly hired engineers, organizations with more than 500 employees were rated higher than organizations with less than 100 employees (*mean difference* = 0.37, *std error* = 0.13, $p = 0.015$). The effect size for this difference of proficiency rating is a small to medium effect.

3.3.2. Results of Organizations' Sector Analysis of Variance

Respondents identified their organization as being categorized as public sector, private sector, or other. Statistically significant differences in the importance ratings between these three groups were found for four of the between group comparisons. The between group comparisons for proficiency noted the presence of two significantly different comparisons.

Difference in importance ratings were determined to have statistically significant differences between groups for *ability to deliver effective presentations*, *ability to plan and think strategically*, *social responsibility*, and *global and cultural awareness*. Tukey pairwise comparisons of the ratings of importance for *ability to deliver effective presentations* ($\bar{x}_{private} = 2.97$, $sd = 1.01$; $\bar{x}_{public} = 3.45$, $sd = 0.70$, $\bar{x}_{other} = 3.29$, $sd = 0.83$, $F = 10.29$, $p < 0.001$, $\eta^2 = 0.048$, $Cohen's F = 0.23$) indicated the public sector rated the importance higher than those who indicated they were in the private sector (*mean difference* = 0.48, *std error* = 0.11 $p < 0.001$). Tukey pairwise comparisons of the ratings for *ability to plan and think strategically* ($\bar{x}_{private} = 3.27$, $sd = 0.88$; $\bar{x}_{public} = 3.50$, $sd = 0.77$, $\bar{x}_{other} = 3.43$, $sd = 0.65$, $F = 5.04$, $p = 0.007$, $\eta^2 = 0.029$, $Cohen's F = 0.17$) indicated differences between the public sector and those who indicated private sector (*mean difference* = 0.23, *std error* = 0.10, $p = 0.047$) such that the public sector ranked the importance higher than the private sector. Tukey pairwise comparisons of the ratings for *social responsibility* ($\bar{x}_{private} = 2.60$, $sd = 1.08$; $\bar{x}_{public} = 3.00$, $sd = 0.97$, $\bar{x}_{other} = 2.79$, $sd = 0.89$, $F = 5.04$, $p = 0.007$, $\eta^2 = 0.029$, $Cohen's F = 0.17$) indicated the public sector rated the importance higher than the private sector (*mean difference* = 0.40, *std error* = 0.12 $p = 0.003$). Tukey pairwise comparisons of the importance ratings for *global and cultural awareness* ($\bar{x}_{private} = 2.54$, $sd = 1.04$; $\bar{x}_{public} = 2.94$, $sd = 0.99$, $\bar{x}_{other} = 2.71$, $sd = 1.14$, $F = 5.55$, $p = 0.004$, $\eta^2 = 0.027$, $Cohen's F = 0.17$) indicated the public sector rated the importance higher than the private sector (*mean difference* = 0.40, *std error* = 0.12, $p = 0.003$). The effect sizes for this difference between public sector organizations and other types of organizations is a small to medium effect.

The between group comparisons for the proficiency of newly hired engineers indicated two statistically significant differences between the sector types, *ability to deliver effective presentations* and *leadership*. Tukey pairwise comparisons of the proficiency ratings for *ability to deliver effective presentations* ($\bar{x}_{private} = 2.53$, $sd = 0.96$; $\bar{x}_{public} = 2.88$, $sd = 0.97$, $\bar{x}_{other} = 2.86$, $sd = 0.86$, $F = 4.27$, $p = 0.015$, $\eta^2 = 0.025$, $Cohen's F = 0.16$) indicated differences between the public sector and those who indicated private sector (*mean difference* = 0.35, *std error* = 0.26, $p = 0.016$) such that the public sector responses were higher than private sector responses. Tukey pairwise comparisons of the ratings for *leadership* ($\bar{x}_{private} = 2.27$, $sd = 0.95$; $\bar{x}_{public} = 2.55$, $sd = 1.00$, $\bar{x}_{other} = 2.71$, $sd = 0.83$, $F = 3.66$, $p = 0.027$, $\eta^2 = 0.021$, $Cohen's F = 0.15$) did not indicate differences that were statistically significant between any of the pairwise combinations of the three types of organizations at the specified threshold to control errors. At times a statistically significant difference does not result pairwise differences due to controls for family Type 1 errors or low power in the comparisons. The effect size for the differences between public sector organizations and private sector organizations is a small to medium effect.

3.3.3. Results of Organizations' Locations Analysis of Variance

Within the profiles of the organizations, the respondents indicated if the organizations were headquartered within the United States or other locations and if they had branches, offices, or plants in countries other than the United States. Of the 489 respondents, 438 were headquartered in the United States, 15 in Japan, 12 in German, 4 in Canada, and 4 in France; the frequency of the headquarters in other countries were either 1 or 2 per country indicated. Respondents indicated that 133 organizations had branches in other countries and 304 did not have branches outside of the United States. The analysis of variance outcomes for both the ratings of importance and for proficiency of newly hired engineers for the locations of headquarters revealed no statistically significant results for any of the comparisons between those organizations with headquarters within the United

States and those headquartered within another country. Similarly, no statistically significant differences were noted for the ratings of proficiency by the location of branches, offices, or plants for the organization. There were statistically significant results noted for the comparison of the ratings for importance by location of branches, offices, or plants for the organization.

An analysis of variance was conducted to assess any differences for countries having branches outside the United States and those located only within the United States. The comparison was made for each of the ratings of importance for the performance of newly hired engineers. A statistically significant difference was determined for two ratings, the importance of the *ability to deliver effective presentations* and the importance of *global and cultural awareness*. Respondents in organizations with branches, offices, or plants outside the United States rated the importance of the ability for newly hired engineers to *effectively present* higher than the rating by respondents from organizations with operations only within the United States ($\bar{x} = 3.19, sd = 0.92; \bar{x} = 2.87, sd = 1.01, F = 9.24, p = 0.003, \eta^2 = 0.022, \text{Cohen's } F = 0.15$). Respondents in organizations with branches, offices, or plants outside the United States rated the importance of *global and cultural awareness* higher than those respondents from organizations that do not have facilities outside of the United States ($\bar{x} = 2.76, sd = 1.01; \bar{x} = 2.35, sd = 1.09, F = 11.35, p = 0.001, \eta^2 = 0.027, \text{Cohen's } F = 0.17$). All other ratings for importance were statistically equivalent for the two organization types, organizations with branches, offices, or plants outside the United States and those within operations only within the United States. The effect sizes for the two soft skills with differences are small to medium.

3.3.4. Results of Primary Line of Business Analysis of Variance

Respondents were asked to describe the primary line of business for their organization. The open-ended responses were recoded into 20 industries. The industries coded are presented in Table 3. For those respondents who did not identify a primary industry, the response was recoded as not declared. Univariate analysis of variance with Tukey pairwise comparisons was conducted for the ratings of importance on each of the soft skills and the ratings of the perception of proficiency of the newly hired engineers in their organization. Partial eta squared values and Cohen's F values were calculated. Statistically significant differences were present for ratings of importance. No between group differences were statistically significant for the ratings of proficiency of newly hired engineers.

Statistically significant differences between industry types were determined for seven of the ratings of importance. The Tukey pairwise comparisons identified between group differences in ratings for four of the measures of differences of means that were statistically significant ratings of importance. The statistical values, partial eta square values and Cohen's F effect sizes, for the soft skills found to have statistically significant differences for their ratings of importance between industries are presented in Table 7. In addition, included in Table 7 are the between industry differences identified in the Tukey pairwise comparisons. The effect sizes for the differences between groups for importance are medium to large effects.

3.3.5. Results of Respondents Role in Organizations Analysis of Variance

The respondents were asked to enter their current title within their organization. The more than 300 responses were coded to 6 position titles: administrator, director, engineer, human resources (HR), manager, and recruiter. Those with missing information were coded as not declared. Between group comparisons were made using analysis of variance for each of the ratings of importance and for each of the ratings of proficiency of the newly hired engineers. Statistically significant differences were found for two of the ratings for importance and for eleven of the ratings for proficiency. Pairwise comparisons of those ratings indicated pairwise differences for only one of the statistically significant between group comparisons for importance and for all of the comparisons for proficiency that were found to have statistically significant between group differences. The outcomes are

presented within Table 8. The effect sizes for the differences between groups for importance are small to medium effects.

3.3.6. Results of Supervisory Roles in Organizations Analysis of Variance

Respondents were asked if they supervised entry-level engineers directly. Once missing data were accounted for through pairwise deletion, the number of respondents indicating yes were 180 and 158 respondents indicated no. Analysis of variance to examine the between group differences resulted in five of the importance ratings and eighteen of the proficiency ratings were statistically significant. Partial eta square effect sizes and Cohen's F effect sizes were calculated for each of the between groups analyses. The outcomes are presented in Table 9. The effect sizes for the differences between groups with statistically significant differences are small to medium effects. An outcome of the between group comparison is that for all of the ratings of soft skills that were statistically significant, both for importance and for proficiency, the rating by the respondent with direct supervision responsibility that rated the newly hired engineers was lower than the rating by the respondent without direct supervision requirements.

3.3.7. Review of Analysis of Variance Outcomes

Because the survey was distributed prior to the pandemic, the outcomes of the ratings of the between group differences by each of the profile variables were shared during summer and early fall 2021 with engineers, managers, and educators through a snowball technique to identify possible reviewers who would offer feedback on the results. These were unstructured interviews with a goal to capture reactions to the between group differences.

An engineer within an organization that primarily works with defense contracts commented, "Those differences where aerospace, defense, and manufacturing are rated higher than technology makes sense. We require all of our aerospace people and those working on the defense and manufacturing contracts to talk directly with the customer to find out what the customer needs and to report on the project. The tech team working on programming and coding pretty much keep to their team and the scrum master talks with the client" [Engineer 1]. This comment supported the outcomes presented in Table 7, the importance ratings for the soft skill, *ability to deliver effective presentations*.

An educator in a four-year higher education role and familiar with interactions of recruiters with students reviewed the results presented in Table 8. The educator commented, "The recruiters I have worked with over the years work diligently to review candidates for internships and positions. They interview faculty and have lunch and dinner meetings with the students to determine which students would fit their organization. Several have told me that they can teach the engineering, but a person must come with the ability to think strategically, work under pressure, be reliable, have good time management, and on. The personal skills and soft skills to be able to work with others are skills they need to demonstrate the first day the start to work" [Educator 1]. The conversation with the educator reinforced that there would be an expectation that the recruiter would rate a newly hired engineer higher than others in the organization because the recruiter would have spent time getting to know the new hire during the recruiting phase.

Table 7. Primary Line of Business Analysis of Variance Results for Importance Ratings of Soft Skills.

				Soft Skill							Partial Eta Sq	Cohen's F
Position Recode (I)	N (I)	\bar{x} (I)	<i>sd</i> (I)	Position Recode (J)	N (J)	\bar{x} (J)	<i>sd</i> (j)	Mean Difference (I-J)	Std Error	Sig		
				<i>Ability to deliver effective presentations</i>							0.132	0.39
Aerospace	19	3.42	0.77	Technology	70	2.57	1.02	0.85	0.24	0.050		
Defense	11	3.73	0.47	Technology	70	2.57	1.02	1.56	0.30	0.018		
Manufacturing	127	3.23	0.89	Technology	70	2.57	1.02	0.66	0.14	<0.001		
Medical	21	3.43	0.68	Technology	70	2.57	1.02	0.86	0.23	0.028		
				<i>Ability to write effectively</i>							0.107	0.35
Medical	21	3.86	0.36	Technology	70	3.19	0.98	0.67	0.18	0.037		
				<i>Ability to deal with uncertainty in relating to people and situations</i>							0.076	0.29
Engineering	29	2.97	1.09	Manufacturing	127	3.56	0.71	0.59	0.14	0.013		
				<i>Ability to work under pressure</i>							0.095	0.32
Aerospace	19	3.68	0.48	R&D	6	2.50	1.37	1.18	0.032	0.033		
Civil Engineering	11	3.91	0.30	R&D	6	2.50	1.37	1.41	0.34	0.009		
Consumer Products	29	3.72	0.53	R&D	6	2.50	1.37	1.22	0.30	0.011		
Manufacturing	127	3.61	0.66	R&D	6	2.50	1.37	1.11	0.28	0.018		
Semiconductors	13	3.85	0.38	R&D	6	2.50	1.37	1.35	0.34	0.012		
				<i>Social responsibility</i>							0.073	0.28
				<i>Leadership</i>							0.084	0.30
				<i>Reliability</i>							0.087	0.31

Note: partial Eta squared effects: small 0.01, medium 0.06, large 0.14; Cohen's F effects: small 0.1, medium 0.25, large 0.4. R&D is research and development. MD: mean difference; SE: standard error, Sig.: significance, *p*.

Table 8. Respondent's Role in Organization Analysis of Variance results for Importance and Proficiency Ratings of Soft Skills.

Soft Skill											Partial Eta Sq	Cohen's F		
Position Recode (I)	N (I)	\bar{x} (I)	sd (I)	Position Recode (J)	N (J)	\bar{x} (J)	sd (j)	Mean Difference (I-J)	Std Error	Sig				
Recruiter				<i>Importance of ability to plan and think strategically</i>									0.038	0.20
				Director				0.54	0.17	0.020				
Recruiter	27	3.33	0.62	<i>Proficiency of ability to communicate effectively with diverse groups of people</i>									0.035	0.19
				Engineer	95	2.75	0.89	0.59	0.18	0.014				
Recruiter	27	3.56	0.64	<i>Proficiency of ability to work under pressure</i>									0.037	0.20
				Engineer	95	2.88	0.99	0.67	0.19	0.008				
Recruiter	27	3.30	0.61	<i>Proficiency of ability to plan and think strategically</i>									0.037	0.20
				Director	70	2.53	0.99	0.77	0.22	0.008				
Recruiter	27	3.30	0.61	<i>Proficiency of ability to understand, articulate, and solve complex problems and make sensible decisions based on available information</i>									0.039	0.20
				Engineer	95	2.88	1.00	0.61	0.19	0.019				
Recruiter	27	3.48	0.51	<i>Proficiency of critical thinking (ability to identify, construct, and evaluate arguments; detect inconsistencies and errors in reasoning; solve problems systematically; reflect on underlying values and beliefs)</i>									0.047	0.22
				Director	70	2.84	0.93	0.68	0.20	0.008				
Recruiter	27	3.52	0.58	<i>Proficiency of staying/ being organized</i>									0.49	0.23
				Engineer	95	2.89	0.90	0.62	0.19	0.013				
HR	42	3.50	0.77	<i>Proficiency of time-management</i>									0.047	0.22
				Director	70	3.01	0.83	0.49	0.16	0.035				
HR	42	3.50	0.77	<i>Proficiency of reliability</i>									0.004	0.22
				Engineer	95	2.94	0.91	0.56	0.15	0.004				
Recruiter	27	3.44	0.58	<i>Proficiency of staying/ being organized</i>									0.047	0.22
				Engineer	95	2.76	0.93	0.69	0.19	0.005				
Recruiter	27	3.78	0.42	<i>Proficiency of reliability</i>									0.45	0.22
				Director	70	3.16	0.81	0.62	0.18	0.011				
Recruiter	27	3.78	0.42	<i>Proficiency of reliability</i>									0.019	0.22
				Engineer	95	3.21	0.87	0.57	0.18	0.019				
Recruiter	27	3.78	0.42	<i>Proficiency of reliability</i>									0.044	0.22
				Manager	93	3.26	0.91	0.52	0.18	0.044				

Table 8. Cont.

Position Recode (I)	N (I)	\bar{x} (I)	sd (I)	Soft Skill				Mean Difference (I–J)	Std Error	Sig	Partial Eta Sq	Cohen’s F
				Position Recode (J)	N (J)	\bar{x} (J)	sd (j)					
				<i>Proficiency of curiosity</i>							0.57	0.25
Recruiter	27	3.81	0.40	Administrator	11	2.91	1.22	0.91	0.30	0.031		
Recruiter	27	3.81	0.40	Director	70	3.20	0.91	0.61	0.19	0.016		
Recruiter	27	3.81	0.40	Engineer	95	3.21	0.87	0.60	0.18	0.013		
Recruiter	27	3.81	0.40	Manager	93	3.23	0.82	0.59	0.18	0.017		
				<i>Proficiency of willingness to take initiative</i>							0.37	0.20
Recruiter	27	3.59	0.50	Engineer	95	2.91	0.98	0.69	0.20	0.008		
				<i>Proficiency of ability to handle multiple priorities</i>							0.041	0.21
Recruiter	27	3.48	0.64	Director	70	2.84	1.04	0.64	0.21	0.036		

Note: partial Eta squared effects: small 0.01, medium 0.06, large 0.14; Cohen’s F effects: small 0.1, medium 0.25, large 0.4. R&D is Research and Development. MD: mean difference; SE: standard error, Sig.: significance, *p*.

Table 9. Respondent’s Supervisory Role of Entry Level Engineers Analysis of Variance Results for Importance and Proficiency Ratings of Soft Skills.

Rating of Soft Skill	Yes (N = 180)		No (N = 158)		F	Sig	Partial Eta Sq	Cohen’s F
	\bar{x} (Yes)	<i>sd</i> (Yes)	\bar{x} (Yes)	<i>sd</i> (No)				
Importance of ability to work under pressure	3.44	0.77	3.66	0.60	10.15	0.002	0.025	0.16
Importance of ability to plan and think strategically	3.21	0.89	3.45	0.80	8.02	0.005	0.019	0.14
Importance of flexibility and adaptability	3.69	0.59	3.82	0.43	5.78	0.017	0.014	0.11
Importance of self-motivation	3.80	0.47	3.91	0.29	7.98	0.005	0.019	0.14
Importance of ability to handle multiple priorities	3.59	0.72	3.74	0.53	6.14	0.014	0.015	0.12
Proficiency of ability to communicate effectively with diverse groups of people	2.78	0.88	3.01	0.74	6.23	0.013	0.018	0.14
Proficiency of ability to deliver effective presentations	2.51	1.01	2.75	0.91	5.30	0.022	0.016	0.13
Proficiency of ability to deal with uncertainty in relating to people and situations	2.61	0.90	2.90	0.89	9.10	0.003	0.026	0.16
Proficiency of ability to work under pressure	2.92	0.91	3.18	0.86	7.59	0.006	0.022	0.15
Proficiency of ability to plan and think strategically	2.58	0.98	2.84	0.98	5.85	0.016	0.017	0.13
Proficiency of ability to understand, articulate, and solve complex problems and make sensible decisions based on available information	2.84	0.95	3.26	0.74	19.64	>0.001	0.055	0.24
Proficiency of critical thinking (ability to identify, construct, and evaluate arguments; detect inconsistencies and errors in reasoning; solve problems systematically; reflect on underlying values and beliefs)	2.92	0.90	3.26	0.74	7.19	0.008	0.021	0.15
Proficiency of creativity: coming up with ‘out-of-the-box’ ideas and solutions	2.76	1.01	2.99	0.87	5.04	0.025	0.015	0.12
Proficiency of focused: the ability to stay focused on a task	2.95	0.92	3.19	0.83	6.28	0.013	0.018	0.14
Proficiency of self-efficacy: belief in one’s capabilities to achieve a goal or outcome	3.07	0.89	3.37	0.81	10.38	0.001	0.030	0.18
Proficiency of staying/ being organized	2.98	0.89	3.28	0.76	10.49	0.001	0.030	0.18
Proficiency of time-management	2.78	0.90	3.14	0.85	14.315	<0.001	0.041	0.21
Proficiency of reliability	3.27	0.85	3.45	0.79	4.17	0.042	0.012	0.11
Proficiency of self-motivation	3.13	0.90	3.50	0.69	17.84	<0.001	0.050	0.23
Proficiency of responsibility	3.21	0.86	3.46	0.75	8.02	0.005	0.023	0.15
Proficiency of curiosity	3.19	0.90	3.42	0.78	6.17	0.013	0.018	0.14
Proficiency of willingness to take initiative	2.99	0.92	3.21	0.90	4.62	0.032	0.014	0.12
Proficiency of handle multiple priorities	2.82	1.02	3.23	0.84	16.22	<0.001	0.046	0.22

An educator with past work experience with small business and with firms that have worked with plants and offices in other countries reviewed the results of the location analysis, which are presented in Section 3.3.3. Although the effect sizes were noted to be small to medium, the educator’s comments provided additional insight into the expectations. “Cultural awareness is so important that sometimes people forget. Some people want rewards and people to notice what they have completed and have their picture on the board as employee of the month. Others would consider that type of recognition as something very bad and think it could actually destroy the functionality of the team if one person is recognized. New hire engineers need to have global and cultural awareness as they take part in global teams and global team meetings” [Educator 2]. Global and cultural

awareness were rated higher by respondents from organizations that have branches, offices, or plants outside of the United States. The experiences and comments made by Educator 2 supported the necessity of engineers preparing to work in an organization with a global reach should include additional study to learn more about the culture and traditions of other locations where the organization operates its business.

During a meeting with a global talent acquisition director, the discussion moved from soft skills requirements for potential employees to the outcomes of the paired t-test results and the analysis to assess the between group differences identified in the analysis of variance of the calculated differences. The director commented, "My company has an expectation that employees will be able to communicate effectively with the members of their team, their clients within the organization and those outside of the organization" [Manager 1]. The director described situations where the soft skills that were rated the highest for importance were essential to the success of the employee's onboarding in the company. The comments included skills such as communication with diverse groups, reliability, time management, and ability to focus on a task. These were described as aspects of employees that were needed to be applied daily. With the pandemic, the team is now all remote and interacts with each other on teams throughout the day. The comments reinforced how necessary it is to further develop these skills after joining a company. Statements supported the finding that new employees do not know the routines and patterns for communication when they begin; however, as they learn about the work they are to do and how to contribute to the bottom line of the organization, the need to apply the soft skills to their work and their relationships in their teams.

These interviews reinforced that the soft skills identified prior to the pandemic were still relevant even though some work has shifted from offices to remote locations. The engineer, educators, and the manager interviewed have been working from their organization offices and with their teams in face-to-face settings.

3.4. Analysis of Participants' Open-Ended Comments at the End of the Survey

The survey also contained space for participants to articulate their thought on areas related to soft skills for entry level engineers in two sections of the survey. The purpose was to allow participants to elaborate on their thoughts about the importance of soft skills and to create an opportunity for them to specify reasons for their responses or draw attention to areas not covered in the survey [56]. The first space was provided at the end of the list of the 26 soft skills that participants were required to rate to capture soft skills that the survey did not assess but employers considered important. The second space was provided at the end of the survey to gather the general thoughts of employers about the importance of soft skills for entry-level engineers in their organizations or line of work. A total of 136 participants added their comments in the first section and 79 in the second. The number of responses (215) highlighted the intent and the seriousness of purpose of the participants and prompted us to consider and analyze their thoughts on the importance of soft skills for entry-level engineers [47]. In the next section, we present an analysis of the comments of the respondents with some actual quotes from participants (P).

3.4.1. Soft Skills Are Often the Final Deciding Factor

Most employers who responded to the open-ended questions emphasized the importance of soft skills for engineering graduates: "Interesting you are focusing on soft skills. When I look at a college hire, it is the soft skills that often are more important than technical knowledge" (P18). Most respondents mentioned that engineers with a willingness to learn can acquire the technical knowledge of skills on the job, while soft skills were the key discriminators during the hiring process: "General skills sets, GPA, and projects/extra-curricular activities that are related to the job weed out 90% of the candidates. The final choice is all about the attitude" (P29). Explaining why soft skills become the deciding factor, the employers argued that, if the engineering graduates were from reputed programs, their technical skills were most often satisfactory. Moreover, "hard skills

are typically solid or buildable from entry level engineers/interns from decent programs” (P124), therefore, what differentiates the one graduate who is selected from the others who were not despite more or less equal technical skills were the candidates’ soft skills. “Your resume gets you in the door and tells me you have the intellect to learn what I have to teach you . . . What I am looking to confirm in new hires is work ethic, commitment and flexibility” (P256). Employers found soft skills to be important for engineers to obtain a job or become hired, but they also found soft skills to be more important for them to grow in their careers: “It is the proficiency in soft skills that allow engineers to become successful technical, programmatic and functional leaders in organizations” (P76).

3.4.2. What Do Employers Look for Specifically during the Hiring Process?

The general consensus was when reviewing short-listed resumes, employers were not swayed by GPA or technical prowess, but instead, they:

... look for experience/activities outside degree requirements and primary disciplines, and employment concurrent with scholastics. This shows a well-rounded person able to work their brain in different ways and manage their own time and responsibilities (P94).

Moreover, employers admitted that “A successful new hire will not be the most technically proficient, instead it will be the one best able to learn and communicate” (P394). Others identified communication skills, critical thinking skills, cultural fit (initiative, curiosity, interpersonal skills), enthusiasm/passion, and related extracurricular interests.

Even though some employers said they were happy with young engineering graduates from good programs, many complained that they generally lacked basic knowledge of workplace norms such as dress, hours of work, work ethics, and basic acceptable behaviors in a work environment: “The primary problem with co-ops and recent grads is their complete lack of understanding of basic norms and expected behaviors in the “real world” (P356). Others echoed similar observations: “they don’t see why it is necessary to be at your desk working at the start of the day and are out the door like a shot at quitting time or even a little before that” (P404). Employers also said, they are forced to:

Spend a lot of time talking about simple things such as telling your supervisor/manager if you will be out or late, communicating when you are done with an assignment—or if you need help. Essentially, we have to teach entry level folks to talk and communicate in most aspects of simply holding a job (P148).

Clarifying that not all young engineers need to be schooled on basic work ethics, one participant specifically said:

This is not universally true of all millennials, but I can tell you nobody ever had to tell me not to do the following, all of which I’ve seen entry-level students do: 1. Show up to a job interview in a shirt and tie—with the shirt untucked! 2. In my second week on the job, ask for Friday off so I could go to a soccer tournament. 3. Fall asleep at my desk, even after being spoken to about it. 4. Spend 75% of my time looking straight down at my phone, even though my work is done on the monitors in front of me (P412).

Some of the same concerns about not being actively engaged at work were expressed by other participants who mentioned that engineering interns and graduates were “really . . . not mentally engaged when he came to work and there was a sense of entitlement with him” (P36).

The employers also identified soft skills they thought were important for entry-level engineers in addition to the 26 that were identified in the survey and also emphasized the soft skills they thought were critical in engineering workplaces in current times.

Engineers are no longer “just” engineers. They work in many cross-functional teams; are held accountable for project plans and schedules; communicating with

diverse teams; leading teams; and being able to communicate effectively, both in writing and verbally (P65).

The soft skills the employers highlighted could be categorized as: (a) communication skills; (b) interpersonal skills; and (c) personality characteristics.

3.4.3. Communication Skills

Most participants identified that engineering graduates more often lacked the ability to communicate or have an interaction with human beings and that they chose to communicate virtually rather than in person, “which creates a challenge for them when they are engaged in an active (real-time) debate with another human being, especially a boomer or x-er” (P9). In addition to causing inter-generational conflicts, the choice of medium of communication was identified as a problem at other levels too:

Just because you ‘drop an email’ does not mean that the person you are exchanging information with is going to respond. And, for any real technical debate, it will be more than 140 characters. One of the comments I make more often than I would like to is, “go see him/her” (P182).

The participants also identified what aspects of communication were critical to entry-level engineers and why. One aspect mentioned by many participants was listening skills. Associated with listening, participants stressed the significance of listening with empathy, being able to take feedback, and following instructions:

I think the ability to listen to users, empathize with them and accept their criticism to create a better product is a very important skill to have (P294).

Too often I see SW [software] engineers dismiss valuable user feedback because they don’t take the time to understand the user’s reasoning, assume the user knows less than the engineer, or because they cannot accept criticism (P52).

It was not surprising that the participants expected new engineers to articulate clearly, and speak up when needed, ask for help, and ask the right questions. More importantly, the employers emphasized that:

The biggest challenge for young engineers is communicating effectively both orally and in writing to people (nontechnical and customers) that are not within their engineering team and/or do not have their level of technical savvy . . . whether they are explaining technology and capability and/or gathering requirements (P172).

In addition, choice of medium to communicate also came up in many responses. The employers felt that new engineers preferred to text rather than talk in person or communicate through “effective and polite emails” (P91).

3.4.4. Interpersonal Skills

Employers consider interpersonal skills very important for engineers. The employers’ comments indicate that even though engineers consider themselves as working with machines, systems, and technology, ultimately, they are working with people and for people: “It’s about solving problems for people; not about machines—you can have a perfect design but if you do not get peoples’ buy in it will not work” (P107). Therefore, interpersonal skills such as respecting older people, being socially aware, and demonstrating emotional intelligence in their interactions are seen to be critical in engineering workplaces. Employers identify the ability to build and maintain professional relationships with colleagues, customers, and clients as being the key for survival and growth even in technical roles. However, there seems to be mixed reactions to the need for leadership skills. Some employers consider leadership skills not essential for entry-level engineers: “I think leadership is a meaningless red herring. Leadership requires many things that come with experience. In addition to teaching people to “lead”, we need to teach them to be humble and follow” (P410).

3.4.5. Personality Characteristics

Among the list of soft skills that employers chose to write down, there were many personality characteristics. These included honesty, humility, commitment to tasks, persistence, confidence, not being stubborn, being an active learner, drive, and quality consciousness. In addition, employers also underscored the need to demonstrate: “engagement and passion to do a good/complete job vs. checking the box as quick as possible” (P21), and creativity in resolving problems, ability to think through complex problems. They said they preferred even-tempered self-starters who show potential to “work without resources” (P3); “dealing with hostile coworkers” (P190); and are able to “pick up work where others left off and easily hand-off for others to pick up” (P312). Additionally, the employers expected new engineers to have the skill of “outcome thinking” or the ability to foresee the response or consequence of their actions. This was one of the main reasons, employers said they preferred slightly mature older graduates:

They need to be reliable, positive, and even keeled. We often prefer more ‘mature’ new hires who took 5–10 years off after college to pursue other interests. They are typically more even keeled than their freshly graduated counterparts (P244).

3.4.6. Summary of Participants’ Comments

Employers clearly described soft skills as the determining factor in the hiring and promotion process. Even though most employers appeared satisfied with the technical skills of engineering graduates, most of them were concerned that they lacked basic knowledge of work ethics and work place norms. Ability to listen with empathy, speak with clarity and politeness, and write clearly and effectively seemed to be very important for employers. While a few employers believed that soft skills cannot be taught and one either has them or not, most others suggested that colleges create opportunities for engineering students to develop soft skills, to be involved in extra-curricular team activities, and to add a class that gave them a glimpse of the real world of work.

4. Discussion

The purpose for this study was to address the gap between what is stated in the literature as expected of more senior members of an organization and what soft skills employers perceive as being important for entry-level engineers to possess and demonstrate. The 26 soft skills rated for importance and proficiency provided a look into perceptions of engineering firms outcomes of recent graduate hires. The open-ended questions illuminated more brightly the need to provide opportunities in courses and within school activities to further develop communication skills, interpersonal skills, and personality characteristics.

The soft skills that employers expect entry level engineers to demonstrate included all 26 of the soft skills on the list; all had a score of 2.65 or higher, out of a scale of 0 to 4, indicating that they are important skills. Most important was Reliability, which was rated as 3.93 out of a possible 4.0 by the respondents to the survey. The open-ended comments reinforced this need for reinforcing reliability. Being considered reliable and having reliability are good social skills; social skills are necessary for successful social interactions [7]. Other top important soft skills to be maintained and improved in engineering education are team work, demonstration of responsibility, self-motivation, and a positive attitude. These can be included within engineering education through a variety of interactive activities such as group projects, independent projects, and activities that require personal accountability.

The perception of employers regarding the general level of proficiency of entry-level engineers when it comes to soft skills is that the entry level employees are moderately proficient on all of the skills. Only positive attitude was rated above 3.5 (3.55 out of 4.0). The others were rated between 2.35 and 3.38 on the level of proficiency. These moderate levels reinforce that engineering education programs are doing good work in that none of the average ratings were below two. More can be conducted to improve the proficiency of the students. Additional opportunities to practice leading others, making presentations, planning and thinking strategically, writing reports and other communications, and dealing

with uncertainty would address those soft skills rated as the least levels of proficiency and in need of improvement.

Those soft skills with the greatest differences between expectations and perceptions of proficiency across the set of soft skills could be grouped into the same categories as the open-ended comments: communication skills, personality traits, and interpersonal skills. The ability to communicate effectively with diverse groups of people and the ability to communicate across age groups are necessary in the globalization of organizations and the age ranges of employees in departments and work teams. Engineering education programs would have the greatest effectiveness for closing the gap between importance and proficiency by focusing on these soft skills. Time management is something that many need to improve; however, new employees without an understanding of the expectations of the work environment would not have a good foundation for time management. It seems that good time management skills balancing work and study while in college might not be enough to develop this skill in the workplace. The open-ended responses alluded to a solution, better preparation in the engineering education preparation of what a work day and work expectations would be. Knowing how to dress and be on time are also part of the need for work expectation awareness.

Between group differences were assessed using analysis of variance and the profile characteristics of organizations and respondents to determine if there were differences by soft skill and its level of importance or the level of proficiency of the newly hired engineers in the organizations. Of the 26 soft skills included in the survey, 25 of the soft skills resulted in a statistically significant between group difference for at least one of the profile characteristics. Positive attitude had an average rating of importance of 3.82 out of 4 and an average proficiency rating of 3.55. In the ranking of proficiency, positive attitude was the highest ranked skill for the entry-level engineers whose proficiency was being considered in the study by the respondents.

This list describes the statistically significant between group comparisons found within the analysis of variance to determine the effects of the organization and respondent profile characteristics. Size, global location, public or private, primary business line, role within the organization, and supervisory requirements had differential effects for the soft skills. Engineering education programs can plan interventions within courses or offer opportunities to practice a soft skill in order to better prepare their graduates for work as an engineer. For example, knowing a large organization has a higher rated level of importance for being able to communicate across age groups, an engineering education program could have students present their senior design projects to a local community center where members of all ages from the community would be present to interact with the students. Another example, engineering education programs can review recommendations for program activities for other engineering accrediting bodies such as the European Commission (ESCO), the European Centre for the Development of Vocational Training (Cedefop), or the Council of European Professional Informatics Societies (CEPIS). Evaluations of program content within these organizations has been reported in series of future program requirements [23–26] that could serve as checklists for programs or for students.

Descriptions of where the differences occurred in the comparisons are provided to help engineering educational program consider modifications or enhancements.

1. Ability to communicate effectively with diverse groups of people
 - a The ratings by the recruiters for the level of importance and the level of proficiency of newly hired engineers were much closer to each other than were the ratings reported by respondents whose roles were coded as engineers, managers, or directors.
 - b Although the effect sizes were small, respondents with direct supervision of newly hired engineers indicated greater differences between their ratings for importance and the level of proficiency exhibited by the newly hired engineer than those respondents without direct supervision.

2. Ability to communicate across age groups
 - a Larger companies have a greater requirement for communication across age groups; >500 had higher ratings than 100–500 firms and differences indicated a small to medium effect size.
 - b Organizations with branches, offices, or plants outside the United States report greater differences between importance and proficiency indicating a need for preparation prior to joining global firms.
3. Ability to deliver effective presentations
 - a Larger companies have a greater expectation for presentation ability.
 - b Organizations with branches, offices, or plants outside the United States report greater differences between importance and proficiency.
 - c Although the effect sizes were small, respondents with direct supervision of newly hired engineers indicated greater differences between their ratings for importance and the level of proficiency exhibited by the newly hired engineer than those respondents without direct supervision.
 - d Public sector organizations report higher importance and higher proficiency ratings than private sector organizations. The effect size for the differences between public sector organizations and private sector organizations is a small to medium effect. This could indicate more opportunity to practice in public sector firms or more opportunity to be observed in private sector firms.
 - e Organizations with facilities outside the United States reported more importance for newly hired engineers to effectively present than in organizations with operations only within the United States.
 - f The type of firm differs in requirements. The level of importance is rated higher for aerospace, defense, manufacturing, and medical compared to technology primary line of business.
4. Ability to write effectively
 - a Medium to large effect size for differences between industry recode of the primary line of business. Respondents who identified as healthcare had reported the newly hired engineers' proficiency exceeded the respondents' ratings for the level of importance for writing effectively. Respondents from organizations whose primary line of business was defense, energy, engineering, medical, or research and development (R&D) coded the level of importance higher than the proficiency of the newly hired engineers such that the between group comparison of each of these lines of business were determined to have statistically significant differences from those respondents in healthcare.
 - b Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
5. Ability to work in teams
 - a Importance of *ability to work in teams*, organizations with more than 500 employees were rated higher than organizations with less than 100 employees.
6. Ability to deal with uncertainty in relating to people and situations
 - a Importance rating higher for engineering compared to manufacturing primary line of business.
7. Ability to work under pressure
 - a Importance ratings were higher for aerospace, civil engineering, consumer products, manufacturing, and semiconductors compared to R&D primary line of business.
8. Ability to plan and think strategically
 - a The public sector ranked the importance higher than the private sector.

9. Ability to understand, articulate, and solve complex problems and make sensible decisions based on available information
 - a Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
10. Critical thinking (ability to identify, construct, and evaluate arguments; detect inconsistencies and errors in reasoning; solve problems systematically; reflect on underlying values and beliefs)
 - a The ratings by the recruiters for the level of importance and the level of proficiency of newly hired engineers were much closer to each other than were the ratings reported by respondents whose roles were coded as engineers, managers, or directors.
 - b Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
11. Creativity: coming up with 'out-of-the-box' ideas and solutions
 - a Ratings are lower by those who supervise than by those who do not supervise entry level engineers.
12. Social responsibility
 - a The public sector rated the importance higher than the private sector.
 - b Statistical difference for importance not evident in pairwise comparison when consider primary line of business.
13. Global and cultural awareness
 - a Small effect size for differences for where have branches, offices, or plants outside United States, no outside branches had greater difference between importance and proficiency than the differences in ratings for those with branches, offices, or plants outside of the United States.
 - b Small to medium effect for the rating of importance for organizations with branches, offices, or plants outside of the United States.
 - c The public sector rated the importance higher than the private sector.
14. Leadership
 - a Organizations with more than 500 employees were rated importance and proficiency higher than organizations with less than 100 employees.
 - b Statistical difference for importance not evident in pairwise comparison when consider primary line of business.
15. Focused: the ability to stay focused on a task
 - a Ratings are lower by those who supervise than by those who do not supervise entry level engineers.
16. Self-efficacy: belief in one's capabilities to achieve a goal or outcome
 - a Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
17. Staying/ being organized
 - a Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
18. Time-management
 - a The ratings by the recruiters for the level of importance and the level of proficiency of newly hired engineers were much closer to each other than were

- the ratings reported by respondents whose roles were coded as engineers, managers, or directors.
- b Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
19. Reliability
 - a Statistical difference for importance not evident in pairwise comparison when consider primary line of business.
 20. Flexibility and adaptability
 - a Ratings are lower by those who supervise than by those who do not supervise entry level engineers.
 21. Self-motivation
 - a The ratings by the recruiters for the level of importance and the level of proficiency of newly hired engineers were much closer to each other than were the ratings reported by respondents whose roles were coded as engineers, managers, or directors.
 - b Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
 22. Responsibility
 - a Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.
 23. Curiosity
 - a Ratings are lower by those who supervise than by those who do not supervise entry level engineers.
 24. Willingness to take initiative
 - a Organizations that identified as other types reported ratings for importance and proficiency that were about the same meaning the newly hired engineers were performing at a level that fulfilled the requirements of the organization. The differences in ratings of the other type organizations compared to public sector organizations were identified as a small to medium effect size.
 25. Ability to handle multiple priorities
 - a Although the effect size is small, those with direct supervision of newly hired engineers responded with greater differences between their ratings for importance than the level of proficiency exhibited by the newly hired engineer.

Supporting the findings of the importance of these soft skills, in 2020, chief human resources and strategy officers from leading global employers identified the top ten skills for employment, skills, and recruitment. Applied across industries and geographies, these included complex problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgment and decision making, service orientation, negotiation, and cognitive flexibility. Members of this group and others released a report in 2021 aimed to build common language and skills at work [57]. Within this report, attitudes for development were delineated as learned behaviors, emotional intelligence traits, and beliefs individuals allow to influence their ideas, interactions with others, and responses to situations [57]. Elements of the attitude category of the World Economic Forum taxonomy include working with people, self-intelligence, and global citizenship and civic responsibility [57]. These three subcategories of attitudes reflect similar topics to those identified as ones newly hired engineers were in need of developing such as active listening, communication, information exchange, following instructions, assisting coworkers, time management, self-control, and meeting commitments.

Even though interactions and communication with others were at the top of the lists for importance and need for improvement, social responsibility and global and cultural awareness had statistically equal ratings for importance and proficiency. It was determined that highlighted focus over the past decade must have resulted in sufficient efforts to have adequate proficiency within these two soft skills yet there is still a need to address communication with diverse groups and effective writing.

4.1. Implications for Engineering Education

By targeting the soft skills identified as most important by employers of entry-level engineers, we hope our research can inform engineering educators where to focus their efforts in developing well-rounded, successful graduates. Curriculum developers could leverage this research to enhance student outcomes by emphasizing the skills employers have identified as most important. Understanding what soft skills employers consider important will enable engineering educators to prioritize those skills within higher education. Prioritizing industry relevant soft skills in turn will enhance the employability of engineering graduates and prepare them better for a professional career.

From a student perspective, knowledge of non-technical skills that are critical for them to enter and grow in their professional careers is crucial to enhancing their employability. Being aware of employer expectations would help students to prepare better for the recruitment process. Intentional focus on soft skills will encourage engineering graduates to attend to acquiring and mastering of soft skills in addition to technical skills taught in their curriculum.

Additionally, we encourage engineering educators to administer soft skills surveys to those employers who hire their graduates. While we have aggregated a large data set, specific employers may value certain soft skills more than others and some institutions may find value in customizing soft skill development to cater to local employer needs. We are relatively early in our research of soft skills for entry-level engineers and see opportunity for additional research to augment our current findings. Two areas we have identified for continued education research include learning soft skills in context and developing structured assessment plans for soft skill acquisition. We believe both of these areas hold promise in refining and enhancing learning outcomes in engineering education. Finally, as this area of research develops, we anticipate that ABET may develop more fine-grained expectations for Engineering Accreditation Commission (EAC) and Engineering Technology Accreditation Commission (ETAC) graduates.

4.2. Implications for Engineering during Industry 4.0

Similar to the outcomes for the explanatory sequential design used in this study to complete confirmatory interviews of the findings, interviews with members of the manufacturing industry in South Africa revealed “soft skills alongside technical skills are even more important than technical skills alone in Industry 4.0” [26] (p. 5). Thinking skills, social skills, and personal skills were identified as essential skills for engineers to meet the requirements of Industry 4.0. Required skills identified in South African firms include soft skills evaluated within this study, that is critical thinking, creativity and innovation, decision making, accountability, application of knowledge, cross-cultural communication and collaboration.

During the last decade, potential new hire engineers of a traditional age (18–24-year-olds) in college have experienced two global crises, the economic downturn and the pandemic. A labor polarization has taken place with an increase in automation to replace routine jobs that formerly were completed by human labor and a change in the interactions expected within the world of work and global labor market [58]. Prior to the pandemic were considerations of the fifth social revolution, a time for the development of new social systems for the continual growth, renewal, and development of the workforce driven by technological and economic forces [59]. Industry 4.0 includes a changing digital culture that relies on collaboration, innovation, data-driven insights, and customer-centricity [60].

Each of these four pillars draws upon professional skills such as intergenerational feedback, inclusive language and interactions, corporate citizenship, open discussions, communication with customers, deepened customer relationships, support for creative solutions and innovation, and development of knowledge hubs to encourage sharing of ideas and enabling other people to participate. The attention on the development of behaviors, mindsets, and practices is a shift in focus from products and outputs to changes in personal actions that are driven by mindsets. While organizations will still rely on key performance indicators and structural performance in the organization through Industry 4.0 and on, the development of people to create safe environments for people to try new things relies on an integration and reinforcement of professional skills. Organizational initiatives are underway to develop digital culture target actions where leaders acknowledge they are human, offer a sense of empowerment to their employees, support new mindsets through reverse mentoring and exchange circles, and establish approaches and levels of vulnerability [60]. The compounded challenges faced during the pandemic and the uncertainty to the future fuels the imperative that people working together and understanding the lives of other people is necessary to equip leaders with the insights and foresight necessary to make decisions in business and education [61].

5. Conclusions

In order to inform students of technical criteria for success, the ABET criteria has communicated the requirements. The success of engineering students in non-technical areas has been outlined yet lacks specificity. This study's purpose was to provide empirical evidence for the establishment of non-technical skills for engineering education. The data within this study were compiled for all industries. The between group comparisons explore differences in the expectations for soft skills by industry. The snowball interviews confirmed the findings of the survey implemented prior to the start of the pandemic were still relevant. Future research is proposed to conduct additional interviews with engineers, managers, and educators to further the explanatory sequential research design and gain greater understanding of the needs within industry and by engineering discipline.

The coverage for this study was quite broad; however, even though nearly 500 respondents participated in the study, not all responded to all of the soft skills questions. Missing data resulted in the removal of the record for the paired differences analysis. This is a potential limitation in that it reduces the number of full data elements to 337. The comparison of the difference in the mean values of the soft skills to the paired differences means were not statistically significant; thus, the deletion of the elements from the paired mean differences did not statistically impact the overall outcome of the need for improvement for 24 of the 26 soft skills studied.

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