Board 402: The Importance of Career Competencies for Engineering Students

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Abstract

Baccalaureate students' acquistion of knowledge, skills, and abilities needed for career success emerge from a combination of classroom and co-curricular activities. Work-related experiential activities (WREAs) offer an opportunity for students to engage in experiential activities before degree completion, and these experiences provide students an important way to refine their skills that facilitate career success. Generally, prior research confirms the benefits of work-related experiential activities in students' transition to the workforce, but more evidence is needed to examine the contribution of WREA participation in the development of career compentencies. This paper is part of a larger study funded by NSF's EHR Core Research Division for Engineering Education and Research. Sixty-three percent of the students surveyed in spring 2021 and spring 2022 at five institutions in one U.S. state said they completed one or more WREAs during their baccalaureate studies. With only a few significant differences by students' gender, race/ethnicity, or financial aid status, student responses indicated high value in developing skills related to career competence, in particular related to professionalism and communication. Student perceptions are detailed, and implications for engineering education are discussed.

Introduction

Connections between college degree completion and successful entry into the workforce is a goal for educators and external stakeholders alike. Postsecondary leaders and federal and state policymakers have identified STEM fields as critical for economic competitiveness [1], [2], including ASEE's efforts to advocate for key priorities in science and technology legislation [3]. College officials are also focused on curricular and co-curricular efforts to ensure STEM student success. To this end, work-related experiential activities (WREAs) such as internships, job shadows, or cooperative education (often called "co-ops"), have been suggested as one tool to support students in developing the kinds of skills needed for employment and career success.

Gaining technical and professional knowledge along with written and oral communication skills are essential to employment for today's engineering students. These skills develop through classroom learning, but students also advance them through experiential education related to post-baccalaureate employment. College officials and students themselves want degree completers to be ready for post-college employment, and as such, the National Association of Colleges and Employers' (NACE) career readiness competencies provide a helpful understanding of the ideas related to career readiness, employability, and life careers [4]. According to NACE, career readiness is "a foundation from which to demonstrate requisite core competencies that broadly prepare the college educated for success in the workplace and lifelong

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career management" [4, Para. 1]. Gained through a variety of actions and activities, the eight career readiness competencies are: career & self-development; communication; critical thinking; equity & inclusion; leadership; professionalism; teamwork; and technology.

These competencies provide a helpful framework to address career-related goals and outcomes relevant across all disciplines, particularly for today's STEM fields. From the lens of social cognitive career theory [5]–[7], WREAs offer an ideal opportunity to combine interests and experiences that can influence students' career interests, attitudes, and preferences. Ideally, work-related experiences build the connections between knowledge, skills, work tasks, and possible career fit. These connections also help students choose WREA activities and formulate educational goals. For employers, career readiness offers an important way to determine a prospective employee's talent by observing one's knowledge and skills across multiple job functions. Further, the principles of career readiness offer a framework for identifying skills that are developed or enhanced through work-related experiential activities.

There is ample evidence that WREAs are associated with positive gains for students in academic achievement, career learning, and the likelihood of employment (with more research available on internships). Despite their benefits, not all students can participate in WREA activities due to financial, sociocultural, or institutional barriers [8]. Further, the Covid-19 pandemic has prompted changes in students' access to experiential education activities, which are often critical to their successful acquisition of employment after graduation. During the pandemic in 2020-2021 and continuing today, more WREA activities are offered remotely, with students completing their WREA tasks outside of traditional office environments. Because of the demonstrated structural advantages gained by students who participate in WREAs, these barriers must be acknowledged and the vast differences in students' experiences not overlooked.

Collectively, these changes urge additional study to better understand the current role of career competencies in baccalaureate education and how they assist students in their transition to employment. Herein, we seek to add to the discussion around career competency skills in the critical STEM field of engineering and to deepen our understanding of WREAs in helping students gain career skills. Further study of students' perceptions of their WREA experiences in this post-pandemic tumultuous period of social and economic change can greatly assist employers and career practitioners in offering activities that improve college completion and student transitions to post-graduation employment.

Research questions guiding this study are:

I. Do engineering students who completed one or more work-related experiential activities perceive them to be helpful in gaining competencies that are related to career success?
II. Do students' perceived gains in career competencies differ by gender, race/ethnicity, or financial aid status?

Literature Review

Work-Related Experiential Activities (WREAs) Defined

Internships, cooperative education programs, and other forms of experiential education are a long-standing part of the academic program for many engineering students. Broadly, we consider

this type of learning as work-related experiential activities, which we call WREAs. They help students connect knowledge learned in the classroom with technical and interpersonal skills that will be called on in the field. The opportunities to apply knowledge in the work setting help prepare students for successful careers. To detail the benefits of WREAs, we draw on literature on internships and co-ops. We rely on Hora et al.'s definition of internships as "a short-term opportunity for students to work (paid or unpaid) for an employer where ideally their academic learning can be applied to real-world tasks" [9, p. 6]. Relatedly, these authors define co-ops as "a formal academic program where students work full-time for a significant duration at a firm while still being considered a student" where "work is standardized, structured and project-based… and includes a contractual agreement between a university and an employer, who 'cooperate' in educating the student" [9, p. 6].

Benefits of WREAs

According to the Association of American Colleges and Universities, internships are considered one of several high-impact practices in which students can participate during college [10]. Through engagement in internships, students learn about the workplace [11], [12], make academic gains [10], [13]–[16], and increase employability [14], [17]–[21]. Similar to internships, cooperative education activities offer students opportunities for personal growth in work competencies, skills, sense of self, understanding of their profession, and employability [22]. Unsurprisingly, Coll and Kalnins [22] reported that co-ops particularly benefit employers in hiring students for subsequent employment due to extended time on the job and greater opportunities to get to know the student. While beneficial in the aggregate, there are significant differences in the quality of and benefits accrued from WREAs based on the structure of the experience [18], [23]–[27]. For example, interns have reported stronger developmental value in internships with strong mentorship supports in place [24], [26]. WREAs are not always standardized or intentionally designed, so simply engaging in a WREA is not enough to ensure students reach their desired outcomes [27].

The benefit of WREAs toward employability originates primarily through skill development and the expansion of personal networks. For example, research suggests that internships serve as a way to build technical, leadership, and entrepreneurial skills [18]. Although postsecondary education and engagement in WREAs contribute to broad human capital and aid in developing an individual's critical thinking, skills are environmentally contextualized in how they form and are employed [28]. As such, we should strive to think of soft skills, such as communication and leadership, within the context of the environment in which they form to adequately understand a student's ability to navigate an organization [29]. Additionally, the skills that employers highly value differ by geographic location, organizational culture, and field [30]. Thus, while WREAs help students build or refine skills, these skill developments should be viewed as multifaceted and contextually situated, requiring a more nuanced view and understanding.

Along with the development of necessary skills and competencies toward employability, WREAs expand a student's personal network. Intentional meetings and unplanned activities, such as conversations at the water cooler, can help the WREA student to meet new people and access the social networks within an organization [19], [20]. Students report seeing their WREA experience as a way to make connections and enhance their résumés [11], [31]. While WREAs

refine students' skills, strengthening one's résumé can also signal their skills to potential employers or provide a broader cultural indication of career readiness.

A recent graduate's likelihood of being hired may depend on various factors sought by employers including prior experience, academics, technical skills, and extracurricular activities. For example, Stepanova et al. found that "experience, GPA, and projects were the most significant parameters for new graduates that recruiters evaluate when reviewing applicants' résumés" [32, p. 17]. Within engineering, employers report that, along with technical knowledge, many soft skills and mindsets are essential and include reliability, teamwork, motivation, attitude or personality, communication, and interpersonal relations. Hirudayaraj et al. [33] reported that some employers might be less focused on technical skills and often use soft skills as the final determinant of the decision to hire the prospective employee.

Especially in light of the non-linear career path for today's workers [34] and changes following the Covid-19 pandemic, understanding the relationship between possession of competencies and career success is important. Ample previous literature confirms the role of competency development and career success. For example, De Vos et al. [35] and Blokker et al. [36] found that employee participation in competency development was positively associated with perceived employability. Perhaps when individuals are aware of their own abilities, they can choose work-related positions that are a better fit. This was the case for Akkermans and Tims [37], who found that career competencies enabled young workers to more astutely hone personal skills for their jobs which, in turn, related to career success. Along with awareness of self-skills, participation in career-relevant experiential activities can help students present themselves (in person and via their résumés) in ways that allow employers to easily identify those who hold high promise for employment success. Clearly, student and employer awareness of skills that translate to career competency is what all educators, students, and employers strive to achieve.

Benefits by Student Demographics and WREA Modality

The Effect of Gender and Race/Ethnicity. WREA participation by women and other underrepresented students can be particularly beneficial, and some recent studies suggest that students from these groups may find greater value in WREA participation than their White and male peers [26], [38]. Despite increases in their numbers, representation of women and other underrepresented students remains relatively low [39] in part due to deeply embedded stereotypes, social factors, and other social structures [40]–[43]. Relatedly, Mann and DiPrete [44] suggested that college majors and students' connections to (or lack of) professional training and careers may combine with gender differences in educational goals that contribute to the persisting gender gap in STEM fields. In line with scholars such as Kolb [45] and Lent et al. [6], we believe that encouraging women and other underrepresented students to participate in WREA activities can benefit them by offering hands-on activities that increase self-confidence and efficacy. Additionally, students who envision success in task achievement and possible career roles will likely be successful and this success can lead to higher overall representations in STEM majors and careers in the future.

Remote Participation. While the availability of traditional, in-person work-related activities remains robust, the Covid-19 pandemic increased the number of remote and hybrid (some time

spent on work tasks in-person and some time on tasks spent remotely) opportunities. To date, much of the research on remote experiences has been conceptual and argued for the replicability of in-person experiences in an online format (for a review of online internship literature, see [46]). WREAs offered via remote and hybrid modalities could, in theory, offer similar opportunities to enhance the same set of skills and abilities. However, some recent work suggests that fully online internships may not truly replicate in-person experiences, with online internship participants reporting lower satisfaction and lower gains in skills and networking than in-person participants. Hybrid opportunities provided some of the benefits of in-person and the limitations of fully online experiences [47]. Hora et al. cautioned, "given the lack of research on online internships, it is premature and inaccurate to claim that they automatically confer similar advantages and positive outcomes to college students" [46, p. 17]. Will these cautions should be heeded, some students may find remote WREAs more suitable than others, and with intentional designs, remote WREAs can potentially work for some students [48].

Given the limited research on online and hybrid experiences and the increase in nontraditional WREA modalities, additional research is warranted as alternative modalities may reveal novel benefits in our post-pandemic environment. This, our study adds to the research on WREAs by further exploring students' perceptions of career competencies collectively by modality, noting those with proficiencies that are enhanced through WREA experiences.

Data and Research Plan

Description of The Survey Instrument

As part of the NSF-funded research project on 'The Path From Education to the Workforce,' we administered the *Career and Employment Planning* survey (via Qualtrics) to select junior and senior level STEM undergraduates in spring 2021 and 2022 at five institutions in one U.S. state. The survey examined select characteristics of the WREA, how many students considered and had taken one or more WREAs, and how they perceived the experience. The survey was e-mailed to all juniors and seniors in two STEM disciplines, one of which was engineering.

The focus of this paper examines the responses of 13 Likert-scaled items that align with the NACE [4] career competencies (see the listing of each competency in Appendix A) from engineering majors. Each of these items asked, 'for the WREAs you participated in, how helpful were the following activities?' (1= not helpful at all, 2= slightly helpful; 3= moderately helpful; 4= very helpful). Three open-ended survey questions were included to further probe respondents' perceptions of their WREA experiences. These open questions asked about the most helpful skill developed, the least helpful experience, and recommendations to improve WREAs for students in the future.

The survey was distributed to 13,667 (7,117 in 2021 and 6,550 in 2022) junior and senior students majoring in engineering at the five universities, and overall, we received usable responses from 1,566 students for a total response rate of 11.5%. Preliminary analyses compared weighted and unweighted results, and since there were very few differences found, analyses presented herein were completed with unweighted data.

Survey Analytic Plan

Following a thorough review of the data, descriptive statistics were completed to review respondents' characteristics and their perceptions of useful skills gained from WREA participation. Select demographic characteristics for survey respondents are included in Table I. As shown, 51% of the respondents were male, and half were students of color. About 63% said they had participated in at least one WREA even though 64% said it was not required for their academic program. Following a review of descriptive analyses, we employed additional analyses to further explore relationships between WREA participation and perceptions of career competencies as well as to examine potential differences by select demographic characteristics.

Table I
Survey Respondents

Variable	N	Percent of valid responses*
Gender		
Male	702	51.1
Female	671	48.9
Race		
White	703	50.0
Black or African American	102	7.3
Hispanic	140	8.9
Asian	354	22.6
Other	107	7.6
WREA required by major		
Yes	135	8.6
No	1001	63.9
Unsure	430	27.5
Participated in WREA		
Yes	747	63.0
No	439	37.0
Mean Age	21.9 (2.31)	
Mean GPA	3.55 (.41)	

*Ns include all valid responses to each question; they do not include respondents who did not identify for the category. The total number of survey respondents was N=1,566. Due to rounding, percentages may not total 100.

Analysis of Open-Ended Questions

We used an iterative coding process for the open-ended questions to further probe student experiences during their WREAs. Three researchers individually inductively coded 25% of each open-ended question with open and axial codes [49]. The researchers then discussed, defined, and refined codes with a larger focus on axial coding. Codes for the first question used the NACE Competencies [4]. For questions 2 and 3, the coders agreed on several thematic areas. And then each resercaher coded the remainder of one question. If a student response mentioned

multiple skills or ideas, it was coded more than once with different or the same axial codes as appropriate. Appendix A shows participant comments as aligned with the NACE Competencies (and our addition of technical skills), example behaviors, and examples of responses coded in each section.

Limitations

Our findings are limited in two ways. First, although the comparison of weighted and unweighted results yielded no significant differences in the findings, we acknowledge low response rates, particularly at two survey sites, threatening the generalizability of the results. Secondly, the closed-ended questions did not ask about the gains in career competencies made in each WREA, only if they were collectively helpful to the career skill items. While these limitations suggest caution, we believe findings are useful in conceptualizing the skills that are valuable in WREAs and perceptions of the skills gained through their WREA participation.

Findings

Addressing Research Question I, results in Table II show students' responses to career competencies that were helped by their WREA participation. In total, 12 of the 13 items had a means score above 3.0 (moderately helpful). The three items with the highest mean scores were *interacting with others in a professional setting, establishing relationships with employers, and understanding how to connect to others in the profession*. Although it was just below the 'moderately helpful' mean score, respondents said that *learning how to write better* was the skill least helped in their WREA (*M*=2.75, SD=.970).

Table II
Responses to Question: *For the WREA(s) you participated in, how helpful were the following activities?*[a]

	Mean[a]	SD
Interacting with others in a professional setting	3.83	.468
Establishing relationships with employers	3.67	.653
Understanding how to connect to the profession	3.57	.696
Improving critical thinking	3.55	.705
Learning how to find answers to questions quickly	3.50	.688
Understanding how to utilize digital technology to solve problems	3.47	.792
Learning how to manage time	3.47	.739
Understanding how to advance in my field	3.43	.786
Developing skills as a leader	3.31	.831
Learning how to work with people of diverse backgrounds	3.30	.860
Applying knowledge learned from class	3.08	.915
Learning how to write better	2.75	.970

Note. Includes responses only for those that participated in at least one WREA (N= 495)
[a] 1= not at all helpful, 4= very helpful

Shown in Appendix B, a Pearson correlation analysis revealed that, in general, there was a weak relationship between the number of WREAs completed and respondents' perception of how

helpful WREAs were to the enhancement of their career competencies. *Learning how to manage my time* (*r*=.107, p= .008), *understanding how to advance in my field* (*r*=.099, p=.015), and *applying knowledge from class* (*r*=.107, p= .026) showed significant correlation values, signaling that students perceived these skills to be more helpful when they participated in a higher number of WREA opportunities. We note, however, that low correlation values of these items indicate only small practical significance.

To address Research Question II, additional analyses were completed to examine students' perceived gains in career competencies by gender, race/ethnicity, and financial aid status. Analyses revealed no significant differences by financial aid status (student receiving need-based aid = yes/no), and only one item showed significant difference by race/ethnicity. On the item *learning how to write better,* Asian students reported higher value than all others (ANOVA *F*=4.018, *p*=.018). Analyses by gender revealed three items with statistically significant differences. As shown in Table III, women reported that their WREAs helped them with *developing their skills as a leader*, *learning how to write better*, and *learning how to work with people from diverse backgrounds* more than their male peers.

Table III
Comparisons by Gender

	Female		Male		T-Test
Dependent Variables	M[a]	SD	M	SD	*t*
For the WREA(s) you participated in, how helpful were the following activities:					
Learning how to manage time	3.50	0.699	3.45	0.768	0.802
Applying knowledge learned from class	3.07	0.943	3.09	0.882	-0.245
Interacting with others in a professional setting	3.86	0.432	3.83	0.463	0.627
Developing skills as a leader	3.38	0.772	3.23	0.876	2.313*
Learning how to write better	2.82	0.937	2.66	0.998	1.990*
Learning how to find answers to questions quickly	3.53	0.665	3.47	0.696	1.027
Being guided by a mentor	3.62	0.684	3.52	0.707	1.646
Establishing relationships with employers	3.70	0.607	3.66	0.670	0.800
Improving critical thinking	3.53	0.724	3.57	0.678	-0.620
Understanding how to connect to the profession	3.61	0.679	3.55	0.707	1.137
Understanding how to advance in my field	3.47	0.776	3.41	0.777	0.816
Understanding how to utilize digital technology to solve problems	3.48	0.786	3.48	0.787	0.089
Learning how to work with people of diverse backgrounds	3.36	0.809	3.24	0.912	1.653*

[a] 1= not at all helpful, 4= very helpful; *p <.05

Most Helpful Skills Developed and Least Beneficial Experiences During WREAs

As mentioned above, the spring 2021 and 2022 surveys contained three open-ended questions; we report on the first two but do not include the third (suggestions for improvement) due to limited responses. The first item asked students about the *most helpful skill* developed and the second asked about the *least beneficial experience* during their WREA. Findings here combine the open-ended responses from both years[2]. Figures 1 and 2 show the number of responses that were identified with a particular code (not the number of times a code was used due to the possibility of representing a duplication). As shown, respondents frequently reported gains in *Professionalism, Communication, Critical Thinking*, and *Technical Skills*.

Professionalism was cited by 39.7% of the respondents. Various professional skills were mentioned, including adaptability, attention to detail, independence, professional interactions, strong work ethic, and organization—two of the most frequent areas covered learning how to operate in a professional environment and time management.

Communication was mentioned by 35.0% of the respondents. Some students suggested that they grew their skills in oral or written communication (often by giving presentations or public speaking) and help-seeking behaviors (communicating when they needed help or were stuck). Other respondents simply suggested they grew in communication skills without providing specific detail.

Technical Skills was mentioned by 22.3% of the respondents. Technical Skills included various skills and knowledge that are unique to the industry. Responses here referenced the use of specific programs that were highly technical, such as computer-assisted drafting programs, or were more general in stating "technical skills."

Critical Thinking was mentioned by 20.7% of the respondents. Responses here came in many forms, from proper resource allocation to the application of school knowledge to more general responses of "critical thinking." The two most common subcategories within Critical Thinking were "critical thinking" and "problem-solving."

Some respondents who wrote at greater length said:
"Professional communication. This skill is very unique to the industry world both in learning how to speak to authority with the right amount of respect and learning how to get your scientific points across in a concise and understandable way."

"Problem-solving. Many classes give you exact guidelines for how to perform projects, and being responsible for more open-ended projects means learning how to be independent and problem-solve."

[2] A small number of respondents (N=140) from 2021 completed the 2022 survey as well. We do not know how many of those respondents may have also answered the open-ended questions in both years, thus the percentages presented below may be slightly higher or lower due to possible repeated respondents.

"In my specific work experience, I was able to get a lot of good hands-on experience, so I was able to gain some very technical skills with power tools and machinery. I also developed better communication skills in general by making sure I participated in meetings, by reporting to my supervisor, and by learning to ask for help when I needed it."

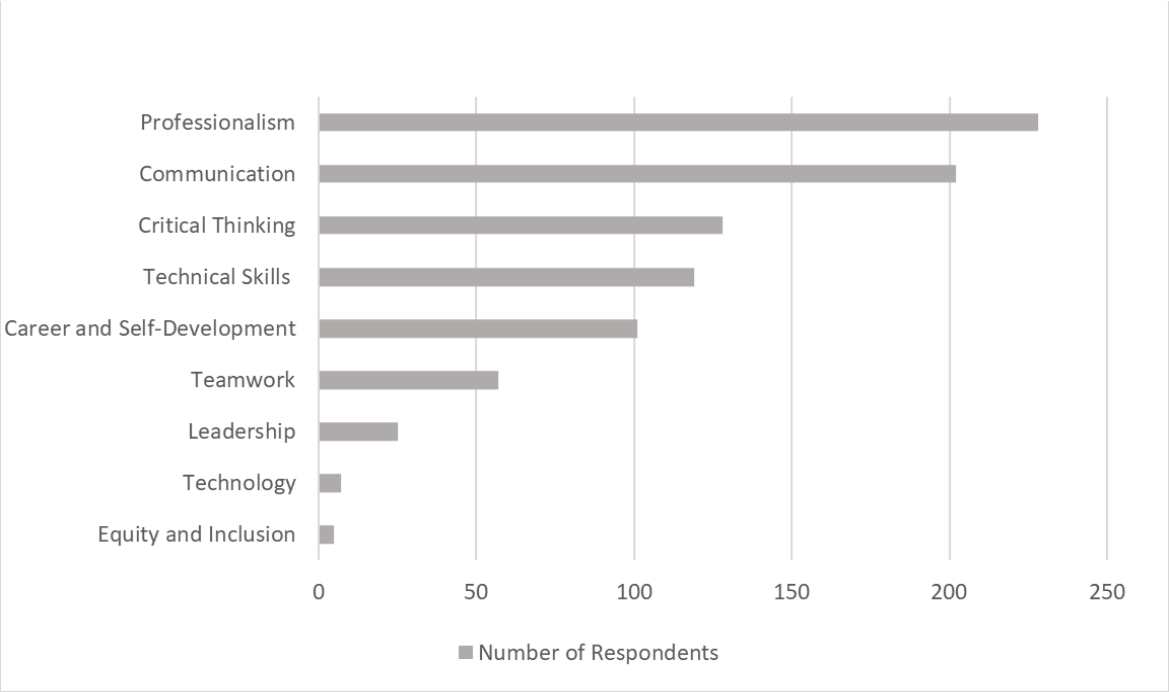

Figure 1. Responses to Question: *What is the most helpful skill you developed during your WREA(s)?*
Note. Responses (N=575) may include multiple codes.
"Technical Skills" was added by the researchers to capture skills (e.g., "AutoCAD") specific to the student's WREA work and may account for the small number of responses coded as "Technology."

The second question allowed students to express aspects of their WREA that were not helpful in their skill development. Question 2 asked, "what is the least helpful experience you had during your WREA(s)?" For this question, students most frequently shared issues related to the work or to structures relating to the design (or lack thereof) of the WREA. Figure 2 shows the most frequent codes for the least helpful experiences.

Lack of Meaningful Work/Task was reported in 46.4% of responses. Within these responses, students suggested that they had downtime too often because they lacked work. Some respondents also discussed issues with their work tasks, believing they were below their skill level or less helpful in their career development.

WREA Structural/Systems Issues were discussed by 21.2% of respondents and included many ideas, including concerns with trainings that they believed were irrelevant, WREAs that lacked

organizational structure, issues with commuting, and material support (e.g., pay, housing, or transportation).

Covid/Remote was the only other substantial category, with13.8% of respondents mentioning this topic. Within the Covid/Remote category, students suggested that Covid-19 health measures required they either report to mostly empty offices or into remote positions. While remote, a number of these students reported feeling isolated or failing to get the support or communication they desired.

Other categories with a limited number of responses included issues related to a need for more mentorship or support, a lack of transferability of skills or experiences from the WREA, interpersonal conflict, sexism or diversity issues, and general communication issues.

Some longer example responses include:

"In each role, there was a small, but not inconsequential, amount of time I spent not being able to do much and getting paid. I know this is common among internships, but I found it very frustrating and often there was nothing I could to remedy it."

"When a summer internship turned into a 3-week virtual experience, I did not end up gaining any technical skills beyond very basic surface level knowledge."

"My manager was gone (not his fault, he had major family emergencies) and the entire team was online. I really didn't get to interact with anyone so I didn't form any personal connections. This was disappointing employment-wise and also socially ☹ [sad face emoticon]*"*

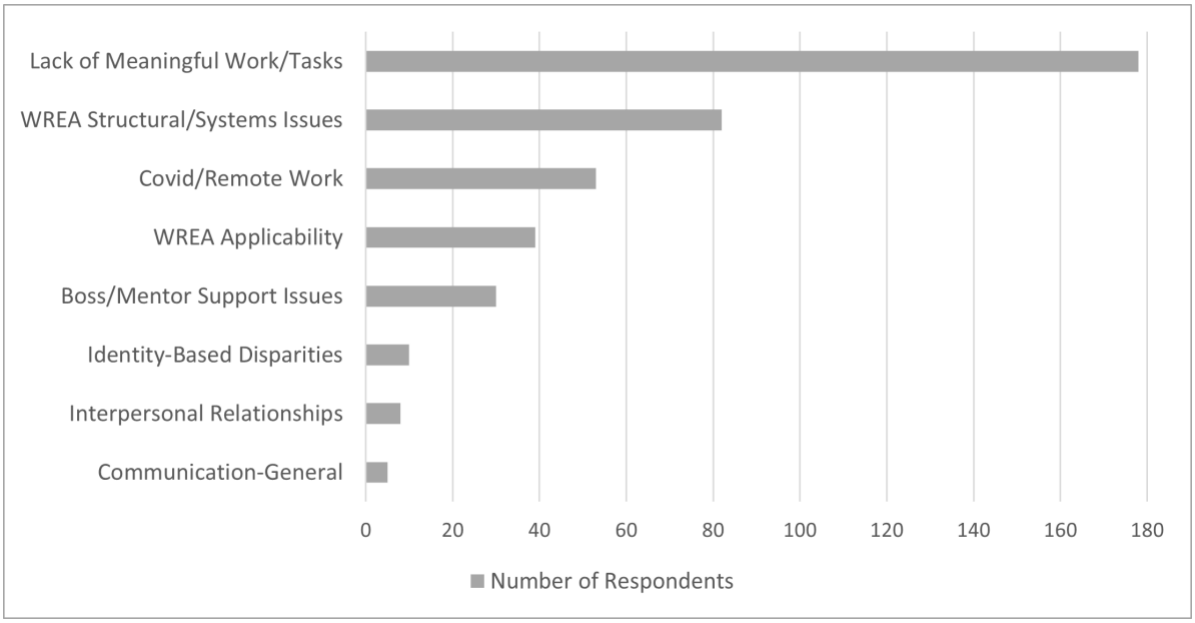

Figure 2 . Responses to Question: *What is the least helpful experience you had during your WREA(s)?*
Note. Valid responses (N=384) may include multiple codes.

Discussion

Career readiness is the foundation for STEM students' demonstration of requisite core knowledge and skills that set the stage for success in the workplace and lifelong career management. The NACE career competencies provide a great way to understand and implement furture strategies related to knowledge gained, skills acquired, and future employability for STEM students. Findings from the spring 2021 and spring 2022 *Career and Employment Surveys* show that many engineering students experience the positive value of work-related activities. Responses to survey items that mirror the NACE competencies showed that the most helpful skills that were developed during their WREA were related to professionalism and communication (mentioned by 39.7% and 35.0% of respondents, respectively). It seems reasonable that work-related activities cement students' understanding of the dynamics of the work environment, how to think and act in broad and focused ways, how to work well with others, and how to communicate in various ways that help one share their knowledge and ideas.

Although the percentage of students who said they developed (or further developed) their skills in teamwork, technology, equity & inclusion, and leadership was smaller, we note that these comments were made by some respondents. In line with Kolb's [45], [50] theory on experiential learning, officials may wish to consider the interplay of the person, environment, and behavior that can impact career choice. Perhaps some WREAs were held for only a few weeks, and had the activity been for longer, maybe a semester or more in length, greater skill increases would have been recognized. Further, because many WREAs were offered remotely or in a hybrid modality (some remote and some in-person), it is quite possible that respondents experienced a somewhat different set of tasks that minimized opportunities related to these skills. Indeed, survey responses herein were obtained during the pandemic when college officials and employers were learning how to navigate the Covid-19 pandemic's social distancing requirements. Perhaps some WREA activities were patched together quickly without adequate time to consider best practices. Although some survey items inquired about the modality of the WREA (remote, in-person, or hybrid), the questions on career competencies were posed for WREAs overall, thus we cannot determine if perceptions of career competencies were different for remote versus in-person experiences. We recommend that more detail for each WREA modality be included in future studies.

Findings showed a gender difference in only three items related to how WREAs helped career readiness skills. Responses from female engineering majors said their WREA activities were more helpful with *developing skills as a leader*, *learning to write better*, and *learning how to interact with people with diverse backgrounds* than responses from male peers. Perhaps the differences by gender were based on the specific WREA location and experience or perhaps the female respondents were more consciously aware of interpersonal dynamics and/or were interested in increasing their skills in these areas. Further inquiry into these differences would be helpful to better understand this finding. Analyses showed no significant differences in how WREAs helped career readiness skills by race/ethnicity or financial aid status. These findings contrast with recent research on underrepresented students that suggests outcomes for WREAs differ based on income, first-generation status, and race [26], [38]. However, while these previous findings showed statistically significant R^2 values, student demographics explained relatively little of the variation in students' perceptions of the value of their WREA participation.

Research to date has focused less on differences in outcomes of WREAs based on student demographics than on differential access to WREA opportunities. We echo Hora et al.'s [38] call for greater study of the perceived impact of all aspects of students' education by demographic factors that highlight the inequalities in access and outcomes based on student characteristics. We acknowledge the diligent previous and current efforts that encourage underrepresented groups in STEM (e.g., NSF ADVANCE and LSAMP; NAE programs, see [51]), and we are confident that WREA participation by women and other underrepresented students helps to increase self-efficacy which, in turn, may likely lead to academic and career success.

Implications for Practitioners

To improve WREA experiences, faculty members and career planning professionals may wish to collaborate with industry officials to consider ways to structure activities that provide the application of knowledge in the work setting, possibly suggesting activities and helping manage students' expectations about their WREA experience [18], [23]–[27]. In addition, employers should ensure that supervisors offer feedback, mentorship, and articulate how to appreciate the benefits of working with a diversity of peers. For WREAs that remain remote, greater attention may need to be given to building teamwork and multiple touchpoints for communication between supervisor and intern. If more WREA activities return to an in-person experience, faculty members and career planning officials may wish to help industry partners plan activities that address career readiness competencies, such as teamwork and feeling confident/comfortable to ask for clarification when needed. Long-term career success will be likely when students as new employees engage proficiently in team-based activities and in a work environment that includes principles of good communication, focused work, and teamwork that support equity and inclusion in its policies and daily practices.

Additional research on students' experiences with career competencies is needed because experiential activities may differ by site, supervisor, location, or focused activity. WREA supervisors that ensure organizational practices and policies that are mindful of gender and underrepresented students' needs are desired, and experiences that can be extended in time may likely add more value and/or skill enhancement. Further, McGee and Spiro [12] suggested that companies can improve internships by integrating interns as regular employees, providing structures such as deadlines that allow for success on projects, and connecting interns to mentors.

Different models (i.e., length of internship, paid vs. unpaid) and modality (i.e., remote vs. in-person) of internships across industries can further explore how and where students obtain the benefits of internships[23], [26]. For example, WREA activities that are carried out remotely need to be designed and carried out with intentionality to ensure that students receive the intended career-readiness benefits [48]. Improved structures for work-related experiential activities could incorporate a more complex view of employability and reinforce the notion of a comprehensive and integrated set of skills rather than simply acquiring disparate aptitudes [29].

In this paper, we focus on the development of career readiness skills and their assistance toward fruitful employment, however, we know that focusing only on skills development for employability overlooks substantial barriers such as cultural and social capital differences, that

are often outside of the control of students as they seek post-graduate employment [28]. More research can help tease out these important nuances. To ensure that internships have the desired outcomes, discussions between students, employers, and college officials should occur to outline structures and successful characteristics that offer greater benefits to interns [20]. To reach this desired goal, student interns should align their work with employer expectations, demonstrate desirable qualities, seek mentorship opportunities, and may wish to journal their WREA to reflect on the experience. Further, employers should provide supervisors who can give detailed guidance and feedback and plan for intern success. Finally, university officials can contribute by building meaningful learning connections to the internship experience and providing support to faculty supervisors who can aid in this connection [20].

Faculty members in engineering (and other STEM disciplines) acknowledge the value of developing a curriculum that helps students to learn the important skills of critical thinking and oral and written communication, but they are also acutely aware of the need to provide students with skills that prepare them for the advanced technologies that exist today as well as new facets tomorrow. Experts who develop today's curricula must be mindful of the increasing diversity of students that enter the field (e.g., [39], [52], [53]), as well as additional ideas gleaned from interesting work that examines student self-efficacy (e.g., [54]) and motivation (e.g., [55]). To keep up with the rapidly changing role of the engineer [56] that ensures the success of today's engineering graduates, academic officials may wish to complete a regular review of the curriculum, mindful of the students that are entering the engineering program, as well as needs of other stakeholders including industry partners and government officials.

References

[1] HDCI Report, "Governor's high demand career initiative report," 2014. Accessed: Nov. 20, 2022. [Online]. Available: https://tcsg.edu/wp-content/uploads/2018/07/HDCI-Report.pdf.

[2] "Fact sheet: Biden-Harris administration actions to attract STEM talent and strengthen our economy and competitiveness," *Whitehouse.gov*, Jan. 21, 2022. https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/21/fact-sheet-biden-harris-administration-actions-to-attract-stem-talent-and-strengthen-our-economy-and-competitiveness/ (accessed Jan. 15, 2023).

[3] M. Quintal and A. Bruno, "ASEE achieves key priorities in science and technology legislation," *ASEE News*, Sep. 20, 2022. https://www.asee.org/about-us/ASEE-News/ASEE-Achieves-Key-Priorities-in-Science-and-Techno (accessed Jan. 15, 2023).

[4] NACE Center, "What is career readiness?," *NACE Center for Career Development and Talent Acquisition*, 2021. https://www.naceweb.org/career-readiness/competencies/career-readiness-defined/ (accessed Nov. 20, 2022).

[5] R. W. Lent, "A social cognitive view of career development and counseling," in *Career development and counseling: Putting theory and research to work*, S. D. Brown and R. W. Lent, Eds. Hoboken, NJ, USA: Wiley, 2005, pp. 101–127.

[6] R. W. Lent, S. D. Brown, and G. Hackett, "Contextual supports and barriers to career choice: A social cognitive analysis," *J. Couns. Psychol.*, vol. 47, no. 1, pp. 36–49, 2000, doi: 10.1037/0022-0167.47.1.36.

[7] R. W. Lent, S. D. Brown, and G. Hackett, "Toward a unifying social cognitive theory of career and academic interest, choice, and performance," *J. Vocat. Behav.*, vol. 45, no. 1, pp. 79–122, 1994, doi: 10.1006/jvbe.1994.1027.

[8] M. T. Hora, M. Wolfgram, Z. Chen, and C. Lee, "Closing the doors of opportunity: A field theoretic analysis of the prevalence and nature of obstacles to college internships," *Teach. Coll. Rec.*, vol. 123, no. 12, 2021.

[9] M. T. Hora, M. Wolfgram, and S. Thompson, "What do we know about the impact of internships on student outcomes?," Center for Research on College-Workforce Transitions, Madison, WI, USA, Research Brief #2, 2017. Accessed: Nov. 20, 2022. [Online]. Available: http://ccwt.wceruw.org/documents/CCWT-report-Designing-Internship-Programs.pdf.

[10] G. D. Kuh, "High-impact educational practices: what they are, who has access to them, and why they matter," Association of American Colleges and Universities, Washington, D.C., USA, 2008. Accessed: Nov. 20, 2022. [Online]. Available: https://www.aacu.org/publication/high-impact-educational-practices-what-they-are-who-has-access-to-them-and-why-they-matter.

[11] A. Frenette, "Making the intern economy: Role and career challenges of the music industry intern," *Work Occup.*, vol. 40, no. 4, pp. 364–397, 2013, doi: 10.1177/0730888413504098.

[12] L. W. McGee and R. L. Spiro, "Internships: A try before you buy arrangement," *SAM Adv. Manag. J.*, vol. 65, no. 2, pp. 41–45, 2000.

[13] J. F. Binder, T. Baguley, C. Crook, and F. Miller, "The academic value of internships: Benefits across disciplines and student backgrounds," *Contemp. Educ. Psychol.*, vol. 41, pp. 73–82, 2015, doi: 10.1016/j.cedpsych.2014.12.001.

[14] S. B. Knouse, J. R. Tanner, and E. W. Harris, “The relation of college internships, college performance, and subsequent job opportunity,” *J. Employ. Couns.*, vol. 36, no. 1, pp. 35–43, 1999, doi: 10.1002/j.2161-1920.1999.tb01007.x.
[15] S. B. Knouse and G. Fontenot, “Benefits of the business college internship: A research review,” *J. Employ. Couns.*, vol. 45, no. 2, pp. 61–66, 2008, doi: 10.1002/j.2161-1920.2008.tb00045.x.
[16] E. T. Parker, C. A. Kilgo, J. K. Ezell Sheets, and E. T. Pascarella, “The differential effects of internship participation on end-of-fourth-year GPA by demographic and institutional characteristics,” *J. Coll. Stud. Dev.*, vol. 57, no. 1, pp. 104–109, 2016, doi: 10.1353/csd.2016.0012.
[17] G. Callanan and C. Benzing, “Assessing the role of internships in the career-oriented employment of graduating college students,” *Educ. Train.*, vol. 46, no. 2, pp. 82–89, 2004, doi: 10.1108/00400910410525261.
[18] A. Frenette, A. D. Dumford, A. L. Miller, and S. J. Tepper, “The internship divide: The promise and challenges of internships in the arts,” Strategic National Arts Alumni Project, Bloomington, IN, USA, 2015.
[19] J. Gault, E. Leach, and M. Duey, “Effects of business internships on job marketability: The employers’ perspective,” *Educ. Train.*, vol. 52, no. 1, pp. 76–88, 2010, doi: 10.1108/00400911011017690.
[20] C. P. Maertz, P. A. Stoeberl, and J. Marks, “Building successful internships: Lessons from the research for interns, schools, and employers,” *Career Dev. Int.*, vol. 19, no. 1, pp. 123–142, 2014, doi: 10.1108/CDI-03-2013-0025.
[21] J. M. Nunley, A. Pugh, N. Romero, and R. A. Seals Jr., “College major, internship experience, and employment opportunities: Estimates from a résumé audit,” *Labour Econ.*, vol. 38, pp. 37–46, 2016, doi: 10.1016/j.labeco.2015.11.002.
[22] R. K. Coll and T. Kalnins, “A critical analysis of interpretive research studies in cooperative education and internships,” *J. Coop. Educ. Internships*, vol. 43, no. 1, pp. 1–13, 2009.
[23] A. Crain, “Understanding the impact of unpaid internships on college student career development and employment outcomes,” NACE Foundation, Bethlehem, PA, USA, 2016. Accessed: Nov. 20, 2022. [Online]. Available: https://www.naceweb.org/job-market/internships/the-impact-of-unpaid-internships-on-career-development/.
[24] P. P. McHugh, “The impact of compensation, supervision and work design on internship efficacy: Implications for educators, employers and prospective interns,” *J. Educ. Work*, vol. 30, no. 4, pp. 367–382, 2017, doi: 10.1080/13639080.2016.1181729.
[25] M. Thompson *et al.*, “Results from the college internship study at North Carolina University,” Center for Research on College-Workforce Transitions, 2020. [Online]. Available: http://ccwt.wceruw.org/documents/CCWT_report_results from U Baltimore.pdf.
[26] M. T. Hora, Z. Chen, E. Parrott, and P. Her, “Problematizing college internships: Exploring issues with access, program design and developmental outcomes,” *Int. J. Work. Learn.*, vol. 21, no. 3, pp. 235–252, 2020.
[27] S. M. Zehr and R. Korte, “Student internship experiences: Learning about the workplace,” *Educ. Train.*, vol. 62, no. 3, pp. 311–324, 2020, doi: 10.1108/ET-11-2018-0236.

[28] M. T. Hora, “Hiring as cultural gatekeeping into occupational communities: Implications for higher education and student employability,” *High. Educ.*, vol. 79, no. 2, pp. 307–324, 2020, doi: 10.1007/s10734-019-00411-6.
[29] M. T. Hora, B. B. Smolarek, K. N. Martin, and L. Scrivener, “Exploring the situated and cultural aspects of communication in the professions: Implications for teaching, student employability, and equity in higher education,” *Am. Educ. Res. J.*, vol. 56, no. 6, pp. 2221–2261, 2019, doi: 10.3102/0002831219840333.
[30] R. J. Benbow and M. T. Hora, “Reconsidering college student employability: A cultural analysis of educator and employer conceptions of workplace skills,” *Harv. Educ. Rev.*, vol. 88, no. 4, pp. 483–516, 2018, doi: 10.17763/1943-5045-88.4.483.
[31] M. T. Hora, E. Parrott, and P. Her, “How do students conceptualise the college internship experience? Towards a student-centred approach to designing and implementing internships,” *J. Educ. Work*, vol. 33, no. 1, pp. 48–66, Jan. 2020, doi: 10.1080/13639080.2019.1708869.
[32] A. Stepanova, A. Weaver, J. Lahey, G. Alexander, and T. Hammond, “Hiring CS graduates: What we learned from employers,” *ACM Trans. Comput. Educ.*, vol. 22, no. 1, pp. 1–20, 2022, doi: 10.1145/3474623.
[33] M. Hirudayaraj, R. Baker, F. Baker, and M. Eastman, “Soft skills for entry-level engineers: What employers want,” *Educ. Sci.*, vol. 11, no. 10, pp. 1–34, 2021, doi: 10.3390/educsci11100641.
[34] L. Eby, M. Butts, and A. Lockwood, “Predictors of success in the era of the boundaryless career,” *J. Organ. Behav.*, vol. 24, no. 6, pp. 689–708, 2003, Accessed: Jan. 15, 2023. [Online]. Available: https://www.jstor.org/stable/4093737 .
[35] A. De Vos, S. Hauw, and B. Van der Heijden, “Competency development and career success: The mediating role of employability,” *J. Vocat. Behav.*, vol. 79, no. 2, pp. 438–447, 2011, doi: 10.1016/j.jvb.2011.05.010.
[36] R. Blokker, J. Akermann, M. Tims, P. Janis, and S. Kaplova, “Building a sustainable start: The role of career competencies, career success, and career shocks in young professionals’ employability,” *J. Vocat. Behav.*, vol. 112, pp. 172–184, 2019, doi: 10.1016/j.jvb.2019.02.013.
[37] J. Akkermans and M. Tims, “Crafting your career: How career competencies relate to career success via job crafting,” *Appl. Psychol. An Int. Rev.*, vol. 66, no. 1, pp. 168–195, 2017, doi: 10.1111/apps.12082.
[38] M. T. Hora, M. Wolfgram, Z. Chen, and J. Zhang, “A sociocultural analysis of internship supervision: Insights from a mixed-methods study of interns at five postsecondary institutions,” Wisconsin Center for Educational Research, Madison, WI, USA, WCER Working Paper No. 2020-8, 2020. Accessed: Nov. 20, 2022. [Online]. Available: http://www.wcer.wisc.edu/publications/working-papers-no-2020-8.
[39] National Science Foundation, “Report on women, minorities, and persons with disabilities in science and engineering,” Alexandria, VA, USA, NSF 21-321, 2021. Accessed: Nov. 20, 2022. [Online]. Available: https://ncses.nsf.gov/pubs/nsf21321/report.
[40] J. Eccles, “Understanding women’s educational and occupational choices,” *Psychol. Women Q.*, vol. 18, no. 4, pp. 585–609, 1994, doi: https://doi.org/10.1111/j.1471-6402.1994.tb01049.x.

[41] M. F. Fox, "Gender, hierarchy, and science," in *Handbook of sociology and gender*, J. S. Chafetz, Ed. New York, NY, USA: Kluwer Academic/Plenum Publishers, 1999, pp. 44–458.
[42] J. Jorstad, S. S. Starobin, Y. Chen, and A. Kollasch, "STEM aspiration: The influence of social capital and chilly climate on female community college students," *Community Coll. J. Res. Pract.*, vol. 41, no. 4–5, pp. 253–266, 2017, doi: 10.1080/10668926.2016.1251358.
[43] A. H. Eagly and W. Wood, "Social role theory," in *Handbook of theories of social psychology*, 2nd ed., P. A. M. Van Lange, A. W. Kruglanski, and E. T. Higgins, Eds. Thousand Oaks, CA, USA: Sage, 2012, pp. 458–476.
[44] A. Mann and T. A. DiPrete, "Trends in gender segregation in the choice of science and engineering majors," *Soc. Sci. Res.*, vol. 42, no. 6, pp. 1519–1541, 2013, doi: 10.1016/j.ssresearch.2013.07.002.
[45] D. A. Kolb, *Experiential learning: Experience as the source of learning and development*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2015.
[46] M. T. Hora, B. Vivona, Z. Chen, J. Zhang, M. Thompson, and R. Brown, "What do we know about online internships? A review of the academic and practitioner literatures," Center for Research on College-Workforce Transitions, Madison, WI, USA, 2020.
[47] M. T. Hora, C. Lee, Z. Chen, and A. Hernandez, "Exploring online internships amidst the COVID-19 pandemic in 2020: Results from a mixed-methods study," Center for Research on College-Workforce Transitions, Madison, WI, USA, 2021–05, 2021. [Online]. Available: https://wcer.wisc.edu/docs/working-papers/WCER_Working_Paper_No_2021_5_4.pdf.
[48] T. Judene Pretti, B. Etmanski, and A. Durston, "Remote work-integrated learning experiences: Student perceptions," *Int. J. Work. Learn.*, vol. 21, no. 4, pp. 401–414, 2020.
[49] M. Miles, A. M. Huberman, and J. Saldana, *Qualitative data analysis: A methods sourcebook*, 4th ed. Thousand Oaks, CA, USA: Sage, 2019.
[50] D. A. Kolb, *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ, USA: Prentice-Hall, 1984.
[51] J. E. McDermott, S. Lee, N. Parshall, S. M. McBride, and E. A. Karr, "Developing a new partnership between universities focused on supporting minority graduate students in engineering," National Academy of Engineering, Washington, D.C., USA, 2022. Accessed: Jan. 15, 2023. [Online]. Available: https://www.nae.edu/File.aspx?id=285963&v=87d70fb1.
[52] R. W. Lent, H. Sheu, D. Singley, J. A. Schmidt, L. C. Schmidt, and C. S. Gloster, "Longitudinal relations of self-efficacy to outcome expectations, interests, and major choice goals in engineering students," *J. Vocat. Behav.*, vol. 73, no. 2, pp. 328–335, 2008, doi: 10.1016/j.jvb.2008.07.005.
[53] A. C. Lesko and J. H. Corpus, "Discounting the difficult: How high math-identified women respond to stereotype threat," *Sex Roles*, vol. 54, no. 1–2, pp. 113–125, 2006, doi: 10.1007/s11199-005-8873-2.
[54] A. Godwin and A. Kirn, "Identity-based motivation: Connections between first-year students' engineering role identities and future-time perspectives," *J. Eng. Educ.*, vol. 109, no. 3, pp. 362–383, 2020, doi: 10.1002/jee.20324.

[55] B. Jones, M. Paretti, S. Hein, and T. Knot, “An analysis of motivation constructs with first-year engineering students: Relationships among expectancies, values, achievement, and career plans,” *J. Eng. Educ.*, vol. 99, no. 4, pp. 316–336, 2010, doi: 10.1002/j.2168-9830.2010.tb01066.x.

[56] G. Tryggvason, M. Thouless, D. Dutta, S. Ceccio, and D. Tilbury, “The new mechanical engineering curriculum at The University of Michigan,” *J. Eng. Educ.*, vol. 90, no. 3, pp. 437–444, 2001, doi: 10.1002/j.2168-9830.2001.tb00624.x.

Appendix A

NACE Competencies for Career Readiness and Examples of Associated Responses

Competency	Example Associated Behaviors	Example Responses
Career and Self-Development	Career planning, networking, attending career-oriented self-development training	Independent learning; The ability to self-advocate; Networking
Communication	Verbal and written communication, help-seeking, active listening	Learning to ask for help; Oral communication; Technical writing
Critical Thinking	Problem-solving, multi-tasking, and anticipating needs and acting	Time sensitive problem solving; The flexibility to work in multiple functions
Equity and Inclusion	Identify systemic barriers to inclusion, flexibility in diverse environments, seek inclusion	Learning to develop relationships with co-workers of all ages, backgrounds, and professions
Leadership	Motivate and inspire, role model, innovate, project management	Taking initiative and adding value with innovative, new ideas
Professionalism	Dependability, be accountable, meet or exceed expectations	Learning to manage time efficiently when working on multiple projects; How to interact in a professional setting
Teamwork	Listen to others, manage conflict, collaborate	Working with a team
Technology	Use appropriate technology, use technology to increase efficiency, learn new technologies	Learning new technologies that I wasn't exposed to in my undergraduate studies.
Technical Skills [a]	Learning specific coding language or software package, learning a specific process	Budgetary Analysis/Forecasting; Growth in my personal technical skills (Excel, Tableau, Power BI).

Note. The example behaviors are not inclusive of all possible examples. See NACE (2021) for a more thorough look at the NACE competencies.

[a] Added by the authors to cover instances of specific tasks they learned or specific technologies. The use of technology was interpreted to be broader than learning specific computer programs or programming languages.

Appendix B

Relationship Between Perceived Helpfulness of Career Skills and Number of WREAs Completed Since Freshman Year

	Pearson *r*
Interacting with others in a professional setting	.076
Establishing relationships with employers	.069
Understanding how to connect to the profession	.056
Learning how to find answers to questions quickly	.063
Improving critical thinking	.052
Understanding how to utilize digital technology to solve problems	.002
Learning how to manage time	.107**
Understanding how to advance in my field	.099*
Developing skills as a leader	.047
Learning how to work with people of diverse backgrounds	.077
Applying knowledge learned from class	.107**
Learning how to write better	-.008

*p<.05; ** p <.01