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RESEARCH ARTICLE

Benefits of Work-Related Experiences and Their Impact on Career Competencies for STEM Students

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Abstract

An important part of STEM education is students' acquisition of knowledge, skills, and abilities needed for career success, all of which emerge from a combination of classroom and co-curricular activities. Work-related experiential activities (WREAs) offer the opportunity for students to engage in experiential activities before degree completion, and these experiences provide students with 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 competencies. This paper focuses on engineering and computer science students' perceptions of skills related to career competence that were enhanced during WREA participation. 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, and in particular, professionalism and communication. Student perceptions are detailed, and implications for STEM research and education are discussed.

Keywords Career competencies · STEM students · Post-degree employment · Experiential education

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Connections between students' acquisition of knowledge and skills, college degree completion, and successful entry into the workforce are goals for educators and external stakeholders alike. Postsecondary leaders and federal and state policymakers have identified STEM fields as critical for economic competitiveness (Committee on STEM Education, 2018; The White House, 2022). Although further work to diversify STEM fields is needed (Blustein et al., 2022; Crain & Webber, 2021; O'Rourke, 2021), STEM participation has increased somewhat over the past decade, in part due to a number of initiatives that have encouraged students to consider STEM careers (e.g., Committee on STEM Education, 2018; National Academy of Engineering, 2018). At the postsecondary level, college officials are focused on curricular and co-curricular efforts to ensure STEM student success, including the acknowledgment that graduates must be equipped to respond to changes in technology as well as changes in the economy and global conditions. Curricular alignment with post-degree success is also important because employers seek STEM graduates who show competence in skills such as oral and written communication, leadership, interdisciplinary thinking, and multicultural understanding. To this end, work-related experiential activities (WREAs) such as internships, job shadows, or cooperative education (often called "co-ops") are one tool to assist students in developing the skills needed for educational and career success.

Gaining technical and professional knowledge along with written and oral communication skills and global awareness are essential to employment for today's STEM students. These skills are developed 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 (NACE Center, n.d.). 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 career management" (NACE Center, n.d., para. 1). Gained through a variety of actions and activities, the eight career readiness competencies are as follows: career and self-development, communication, critical thinking, equity and 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 engineering and computer science majors who are deeply centered in STEM fields. From the lens of social cognitive career theory (Lent, 2005; Lent et al., 1994, 2000), 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 opportunities 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 (e.g., Bolli et al., 2019; Hora, 2020; Knouse & Fontenot, 2008; McGee & Spiro, 2000; Oswald-Egg & Renold, 2021; Wolfgram & Ahrens, 2022). Despite their benefits, not all students can participate in WREA activities due to financial, sociocultural, or institutional barriers (Hora et al., 2021). Further, the Covid-19 pandemic prompted changes in students' access to experiential education activities, which can be critical to their successful acquisition of employment after graduation. During the pandemic in 2020–2021 and continuing today, more WREA activities are offered remotely (NACE Report, 2020; Slater & Cojanu, 2021), with students completing their WREA tasks outside 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 must not be 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 fields of engineering and computer science that can 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:

1. What percentage of baccalaureate-level engineering and computer science students participate in WREAs? How many of these students participate in more than one WREA?
2. Do students who participate in work-related experiential activities perceive them to be helpful in gaining competencies that relate to career success?
3. Do WREA students' perceived gains in career competencies differ by gender, race/ethnicity, or financial aid status?

Literature Review

Work-Related Experiential Activities (WREAs) Defined

A number of personal factors and experiences have a substantial impact on learning for STEM students and their future careers (Han et al., 2021; Wang, 2013). Along with motivation and self-efficacy, experiences in the academic and co-curricular environment play an important role in students' decision to choose a STEM degree and career. Internships, cooperative education programs, and other forms of experiential education are considered a high-impact practices (Kuh, 2008) and are a long-standing experiential part of the academic program for many STEM 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. Furthermore, the opportunities to apply knowledge in the work setting help prepare students for successful, long-term careers. To detail the benefits of WREAs, we draw on research on internships and co-ops. We rely on Hora et al.'s (2017) 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" (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" (p. 6).

Benefits of WREAs

According to the Association of American Colleges and Universities, internships and other similar work-related experiences are considered a high-impact practice in which students can participate during college (Kuh, 2008) and are increasingly mandated as a graduation requirement (Hora et al. 2020b). Through engagement in internships, students learn about the workplace (Frenette, 2013; McGee & Spiro, 2000), make academic gains (Binder et al., 2015; Knouse et al., 1999; Knouse & Fontenot, 2008; Kuh, 2008; Parker et al., 2016), enhance career learning (Dirienzo, 2016; McGee & Spiro, 2000; Zehr & Korte, 2020), and increase employability (Callanan & Benzing, 2004; Frenette et al., 2015; Gault et al., 2010; Knouse et al., 1999; Maertz et al., 2014; Nunley et al., 2016). 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 (Coll & Kalnins, 2009). Unsurprisingly, Coll and Kalnins (2009) 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 (Crain, 2016; Frenette et al., 2015; Hora et al., 2020a; McHugh, 2017; Thompson et al., 2020; Zehr & Korte, 2020). For example, interns have reported stronger developmental value in internships when strong mentorship support is in place (Hora et al., 2020a; McHugh, 2017). WREAs are not always standardized or intentionally designed, so simply engaging in a WREA is not enough to ensure students reach their desired outcomes (Zehr & Korte, 2020).

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 (Frenette et al., 2015). 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 (Hora, 2020). 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 (Hora et al., 2019). Additionally, the skills that employers value highly differ by geographic location, organizational culture, and field (Benbow & Hora, 2018). 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 developing the 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 (Gault et al., 2010; Maertz et al., 2014). Students report seeing their WREA experience as a way to make connections and enhance their résumés (Frenette, 2013; Hora et al., 2020a). 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.

Some previous literature also acknowledges barriers to WREA participation (e.g., Dirienzo, 2016; Frenette et al., 2015; Hora et al., 2017, 2019; Hora et al., 2020a). For example, Hora et al. (2019) found that 64% of internship non-participants wanted to participate but were unable due to financial, sociocultural, or institutional barriers. These barriers can include the need to work for pay (if the WREA is unpaid), transportation issues, school workloads, or a general lack of access to opportunities.

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. (2022) found that "experience, GPA, and projects were the most significant parameters for new graduates that recruiters evaluate when reviewing applicants' résumés" (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. For example, Hirudayaraj et al. (2021) reported that some employers might focus less on technical skills and often use soft skills as the final determinant when hiring a prospective employee.

Especially in light of the non-linear career path for today's workers (Eby et al., 2003) 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. (2011) and Blokker et al. (2019) found that employee participation in competency development was positively associated with perceived employability. Perhaps when individuals are aware of their abilities, they can choose work-related positions that are a better fit. This was the case for Akkermans and Tims (2017), 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.

The Effect of Gender, Race/Ethnicity, and Financial Aid Status

WREA participation by women and other underrepresented students can be particularly beneficial to their personal success (e.g., Smith et al., 2023), and some recent studies suggest that students from these groups may find greater value in WREA participation than their White and male peers (Hora et al., 2020a, c). Despite increases in their numbers, representation of women and other underrepresented students remains relatively low (National Science Foundation, 2021), in part due to deeply embedded stereotypes, social factors, and other social structures (Eagly & Wood, 2012; Eccles, 1994; Fox, 1999; Jorstad et al., 2017). Relatedly, Mann and DiPrete (2013) 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 addition to gender and racial identity, and despite holding aspirations to engage in these activities, participation in WREAs differs by students' socioeconomic status and first-generation status. For example, financial barriers exist for students unable to accept unpaid internships, which are more prevalent for women, students of color, and students from low-income backgrounds (Hora et al., 2022). Students from low-income backgrounds are also more likely to need to work additional jobs, leaving little time or energy for WREA participation. Additional barriers for low-income and first-generation college students include sociocultural factors such as lack of access to dominant social networks wherein, who one knows can provide access to a greater number of opportunities (Hora et al., 2021). Institutional barriers also exist for students from low-income and working-class backgrounds, as students from these backgrounds are more likely to attend institutions that cannot provide the same level of service and support for career preparation or internship engagement (Hora et al., 2021).

In line with scholars such as Kolb (2015) and Lent et al. (2000), we believe that encouraging and providing information, support, and pathways for 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 (Han et al., 2021; Lent et al., 2000).

Data and Research Plan

Description of the Survey Instrument

As part of a larger research project examining baccalaureate students' path from college to the workforce, we developed, pilot-tested, and then administered the *Career and Employment Planning* survey (via Qualtrics) to junior and senior-level engineering and computer science undergraduates in spring 2021 and 2022 at five institutions in one U.S. state. We created the survey questions based on the project's overarching research questions to examine the benefits of WREA participation and an

understanding of the relevant literature. 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. Demographic questions asked for respondents' gender (male, female, or self-identified), and race/ethnicity (following standard five categories used for IPEDS from the U.S. Department of Education), first-generation status (yes or no), and financial aid status (receiving need-based financial aid, receiving merit-based scholarship(s), receiving an educational loan, or receiving no financial aid). Students responded based on their definition of these demographics, and could choose to not answer any of the items including demographic questions.

An important part of the survey included responses to 13 Likert-scaled items that align with the NACE Center's (n.d.) career competencies (see the listing of each competency in Appendix A). Each item 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*). Two open-ended survey questions were included to further probe respondents' perceptions of their WREA experiences and inquire about the most helpful skill developed and the least helpful experience.

Following IRB approval at all participating institutions, a list containing email addresses and first and last names for all non-FERPA restricted junior and senior level students in engineering and computer science was received from each institution's Institutional Research office. We worked with a university official at each institution (typically in the institutional technology division) to ensure the survey was not whitelisted (not identified as spam). We carefully reviewed all survey questions to ensure that they followed our project goals, and all questions were reviewed by a staff member in the university's survey research center to ensure clarity. Following pilot testing with three groups of students at the researchers' home institution, we electronically distributed the survey to 22,121 (11,262 in 2021 and 10,859 in 2022) actively enrolled junior and senior students majoring in engineering and computer science at four public universities and one private university representing different regions of the same state (e.g., two public universities are large, selective, predominantly white research-intensive institutions, one institution is categorized as a historically Black university, and the fourth public university is a mid-sized, less-selective comprehensive university). Following the initial request to complete the survey, students received three to four reminders to complete the survey (due to semester schedules, some students received the survey before spring break and thus received an extra reminder after spring break). The survey link was open for each student for about 5–6 weeks, but once a student had submitted the link, s/he could not open the survey or resubmit a second time. Overall, we received usable responses from 2300 students for a total response rate of 10.4%.

Survey Analytic Plan

Following a thorough review of the data, descriptive statistics were completed to examine respondents' characteristics and their perceptions of useful skills gained from WREA participation. Preliminary analyses compared weighted and

Table 1 Descriptive statistics

Variable	*N*	Percent of valid responses
Gender		
Male	1118	55.8
Female	884	44.2
Race		
White	903	43.9
Black/African American	166	8.1
Hispanic	166	8.1
Asian	659	32.0
Other	163	7.9
Major		
Computer science	733	31.9
Engineering	1566	68.1
Financial aid		
Need-based	458	22.5
Merit-based	1264	62.1
Educational loan	504	24.8
No financial aid	505	24.8
Mean age	21.9	
Mean GPA	3.60	

The total number of survey respondents was $N = 2300$. Ns include all valid responses to each question; totals shown do not include respondents who did not identify for the category. Due to rounding, percentages may not total 100

unweighted results, and since very few differences were found, analyses presented herein were completed with unweighted data. Select demographic characteristics for survey respondents are included in Table 1. As shown, 56% of the respondents were male, and more than half were students of color. About 60% said they had participated in at least one WREA, even though 61% 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 and examine potential differences by select demographic characteristics.

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 (Miles et al., 2019). The researchers then discussed, defined, and refined codes, focusing on axial coding. After discussing the inductive codes, the researchers decided that the first open-ended

question would be deductively coded using the NACE Competencies. Then, the coders agreed on several thematic areas. Next, each researcher coded the remainder of one of the open-ended questions. If a student's 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. We also include the inductive codebook used to analyze open-ended Question 2 in Appendix B.

Limitations

Our findings are limited in four ways. First, we acknowledge low response rates, particularly at two survey sites, threatening the generalizability of the results. Secondly, we did not calculate reliability statistics for the survey instrument, but discussions with students who completed the survey during pilot testing provided confidence that the items were clear and relevant. In addition, we believe that the 13 survey questions (shown in Table 4) closely align with the NACE career competencies. Third, the closed-ended items did not ask about the gains in career competencies made in each WREA separately, only if they were collectively helpful to the career skill items. Lastly, this study occurred during a time when college officials and employers were learning how to navigate the Covid-19 pandemic. The required physical distancing prompted students and employers to determine quickly how to continue offering work-related experiences, but often in non-office locations. It is possible that students' perceptions of their WREAs may have been affected by last-minute changes to tasks assigned and/or the location, such as working from home with high levels of video-based communication. While these limitations suggest caution, we believe findings are useful in conceptualizing the skills valuable in WREAs and the perceptions of skills gained through their recent WREA participation.

Findings

Addressing Research Question 1, results in Table 2 show that 60% of the respondents completed at least one WREA during their baccalaureate studies. Of those who participated in WREAs, 61% completed more than one WREA, and about a third completed three or more of these experiential activities. Findings show that many students are thinking about possibly participating in WREAs even before they matriculate to college; 43% of respondents said they thought about WREAs before they began their freshman year. As one activity that can contribute to post-degree career success, 25% of the respondents said that they had received a job offer from the company with whom they had completed a WREA.

To further address Research Question 1, a Pearson correlation analysis shown in Table 3 revealed that, in general, there was a weak relationship between the number of WREAs completed and respondents' perception of how helpful WREAs were in enhancing their career competencies. *Understanding how to advance in my field*

Table 2 WREA participation

Variable	*N*	Percent of valid responses
Participated in a WREA:		
Yes	1026	59.9
No	687	40.1
WREAs completed since entering college:		
One	394	38.4
Two	314	30.6
Three	196	19.1
Four	83	8.1
Five to seven	39	3.8
WREA required by major:		
Yes	237	10.3
No	1407	61.2
Unsure	656	28.5
Began thinking about WREAs:		
Before starting college	444	43.5
Freshman year	379	37.2
Sophomore year	144	14.1
Junior year	46	4.5
Senior year	7	0.7
Received full-time job offer for post-graduation:		
Yes, with one of WREA companies	51	25.8
Yes, with another company	67	34.2
No	79	39.9

Ns include all valid responses to each question. Due to rounding, percentages may not total 100

($r = .132$, $p < .001$), *Learning how to manage my time* ($r = .124$, $p < .01$), *Establishing relationships with employers* ($r = .099$, $p < .001$), and *Developing skills as a leader* ($r = .110$, $p < .01$) were the top four significant correlation values. The significant findings in Table 3 indicate that students perceived some competency skills to be more helpful for their career 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 and must be reviewed with caution.

Addressing Research Question 2, results in Table 4 highlight students' responses to career competencies that they believe were helped by their WREA participation. In total, 12 of the 13 items had a mean 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 *Being guided by a mentor*. Although it was just below the moderately helpful mean score, respondents said that *Learning how to write better* was the skill least helped by their WREA ($M = 2.71$, SD = 0.971).

Table 3 Relationship between perceived helpfulness of career skills and number of WREAs completed since freshman year

Career Skill	Pearson *r*
Interacting with others in a professional setting	.091**
Establishing relationships with employers	.117***
Understanding how to connect to the profession	.089*
Learning how to find answers to questions quickly	.093**
Improving my critical thinking	.079*
Understanding how to utilize digital technology to solve problems	.037
Learning how to manage my time	.124**
Understanding how to advance in my field	.132***
Being guided by a mentor	.095**
Developing skills as a leader	.110**
Learning how to work with people of diverse backgrounds	.081*
Applying knowledge learned from class	.072*
Learning how to write better	.032

*p<.05; ** p <.01, *** p < .001

To address Research Question 3, additional analyses were completed to examine students' perceived gains in career competencies by gender, race/ethnicity, and financial aid status. As shown in Table 5, analyses by gender revealed three items with statistically significant differences. More women reported that their WREAs

Table 4 Responses to question: "For the WREA(s) you participated in, how helpful were the following activities?"

Activity	Mean[a]	SD
Interacting with others in a professional setting	3.80	.513
Establishing relationships with employers	3.64	.669
Being guided by a mentor	3.57	.700
Understanding how to connect to the profession	3.55	.700
Improving my critical thinking	3.53	.721
Learning how to find answers to questions quickly	3.52	.685
Understanding how to utilize digital technology to solve problems	3.50	.763
Learning how to manage my time	3.46	.743
Understanding how to advance in my field	3.42	.802
Learning how to work with people of diverse backgrounds (e.g., race, ethnicity, age, gender, sexual orientation, and/or religion)	3.28	.864
Developing my skills as a leader	3.25	.862
Applying knowledge learned from class	3.10	.915
Learning how to write better	2.71	.981

This table includes all students who responded that they had participated in at least one WREA (N = 1026). [a] Activity responses were scaled on a four-point scale with 1 = *not at all helpful*, 4 = *very helpful*

Table 5 Comparisons by gender to the question "For the WREA(s) you participated in, how helpful were the following activities?"

Dependent variables[a]	Female		Male		*T*-test
	M	SD	*M*	SD	*t*
Learning how to manage my time	3.48	.703	3.44	.767	.807
Applying knowledge learned from class	3.08	.942	3.11	.885	.451
Interacting with others in a professional setting	3.85	.447	3.79	.521	1.694
Developing my skills as a leader	3.35	.789	3.16	.905	3.108**
Learning how to write better	2.79	.961	2.63	.992	2.296*
Learning how to find answers to questions quickly	3.56	.653	3.48	.705	1.523
Being guided by a mentor	3.62	.690	3.53	.708	1.863
Establishing relationships with employers	3.67	.644	3.62	.682	.910
Improving my critical thinking	3.54	.701	3.52	.734	.319
Understanding how to connect to the profession	3.61	.670	3.52	.722	1.824
Understanding how to advance in my field	3.46	.789	3.39	.802	1.164
Understanding how to utilize digital technology to solve problems	3.51	.760	3.50	.763	.181
Learning how to work with people of diverse backgrounds	3.37	.806	3.20	.905	2.692**

[a]Variables were scaled on a four-point scale with 1 = not at all helpful, 4 = very helpful

*p <.05, ** p <.01

helped them with *Developing skills as a leader*, *Learning how to write better*, and *Learning how to work with people from diverse backgrounds* than their male peers.

Table 6 details differences in the benefit of WREA participation for career competencies by race/ethnicity. A multiple means comparisons test showed significant differences in three questions related to career competencies. In *Learning how to manage my time*, Black/African American students perceived their WREA as more helpful than Asian, White, and Other peers. For *Learning how to interact with others in a professional setting*, White respondents perceived their WREAs as more helpful than students in the Other race category. For *Learning how to work with people of diverse backgrounds*, Black/African American respondents said their WREA experiences were more helpful compared to peers in the Other race group.

Analyses were also completed to examine differences by students' financial aid status. Analyses revealed no significant differences in the mean number of WREAs taken by financial aid status (the mean number of WREAs was 2.06 for need-based aid respondents versus 2.01 for non-need-based aid respondents), nor were there significant differences in perceived benefits for career competencies by financial aid status (a dichotomous variable, receiving any aid = yes/no).

A final set of analyses examined possible intersections between gender, race/ethnicity, and financial aid status. A multivariate analysis of variance revealed no significant effects for the interaction between gender and race/ethnicity. Further, no significant effects were found for the three-way interactions by gender, race, and financial aid status.

Table 6 Mean scores for career competency items by race/ethnicity

Career competency	Asian		Black/ African American		Hispanic		Other		White		Significant differences
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Learning how to manage my time	3.44	0.764	3.72	0.497	3.51	0.751	3.30	0.806	3.45	0.730	Black/AA to White ($p = .011$); Black/AA to Asian ($p = .016$); Black/AA to Other ($p = .004$)
Understanding how to apply the knowledge I learned in class	3.09	0.944	3.40	0.857	3.28	0.854	3.06	0.938	3.04	0.906	
Learning how to interact with others in a professional setting	3.80	0.513	3.84	0.472	3.82	0.468	3.58	0.735	3.84	0.465	White to Other ($p = .039$)
Developing my skills as a leader	3.18	0.889	3.50	0.715	3.46	0.785	3.17	0.909	3.24	0.858	
Learning how to write better	2.83	1.034	2.90	0.872	2.70	1.021	2.72	1.001	2.62	0.947	
Learning how to find answers to questions quickly	3.60	0.674	3.62	0.635	3.54	0.703	3.51	0.639	3.46	0.701	
Being guided by a mentor	3.56	0.745	3.70	0.580	3.55	0.689	3.53	0.659	3.57	0.703	
Establishing relationships with employers	3.58	0.711	3.68	0.653	3.70	0.654	3.58	0.656	3.67	0.656	
Improving my critical thinking	3.47	0.766	3.64	0.631	3.68	0.571	3.53	0.679	3.51	0.739	
Understanding how to connect to the profession	3.54	0.722	3.70	0.614	3.65	0.694	3.44	0.716	3.55	0.697	
Understanding how to advance in my chosen field	3.43	0.829	3.56	0.812	3.41	0.746	3.33	0.848	3.41	0.786	
Understanding how to utilize digital technology to solve problems	3.52	0.790	3.62	0.635	3.52	0.731	3.42	0.727	3.49	0.773	
Learning how to work with people of diverse backgrounds	3.32	0.862	3.60	0.756	3.39	0.861	3.15	0.881	3.23	0.866	Black/AA to Other ($p = .026$)

This table used multiple comparison test with Tamhane's correction for unequal sample sizes and the IPEDS 5-category groupings for race/ethnicity. Respondents by group are as follows: Asian, $N = 223$; Black/African American, $N = 50$; Hispanic, $N = 60$; Other, $N = 80$; White, $N = 414$

Most Helpful Skills Developed and Least Beneficial Experiences During WREAs

To gather further insights into students' perceptions of their WREA experiences, one open-ended question asked about the *most helpful skill* developed, and a second asked about the *least beneficial experience* during their WREA. The findings here combine the open-ended responses from both years.[1] 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 37.9% 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 were *Learning how to operate in a professional environment* and *Time management. Communication* was mentioned by 35.9% 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 (i.e., communicating when they needed help or were stuck). Other respondents simply suggested they improved their communication skills without providing specific details. *Technical Skills* was mentioned by 23.9% of the respondents and included various skills and knowledge 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 23.5% of the respondents. Responses here came in many forms, from proper resource allocation to applying school knowledge to more general responses of "critical thinking."

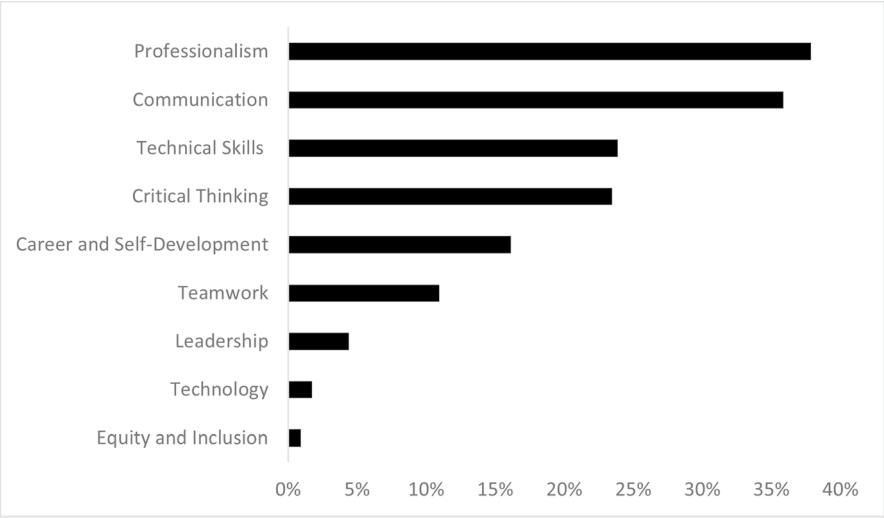
Some respondents wrote at greater length. For example, one student reported that they grew most in *Communication*:

> 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.

Another student suggested they gained experience with problem-solving without the structure they believed they often had in their classes, saying, "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." Within this response are elements of both *Critical Thinking* (i.e., problem-solving) and *Professionalism* (i.e., gaining professional independence). Another student reported gains in several skills:

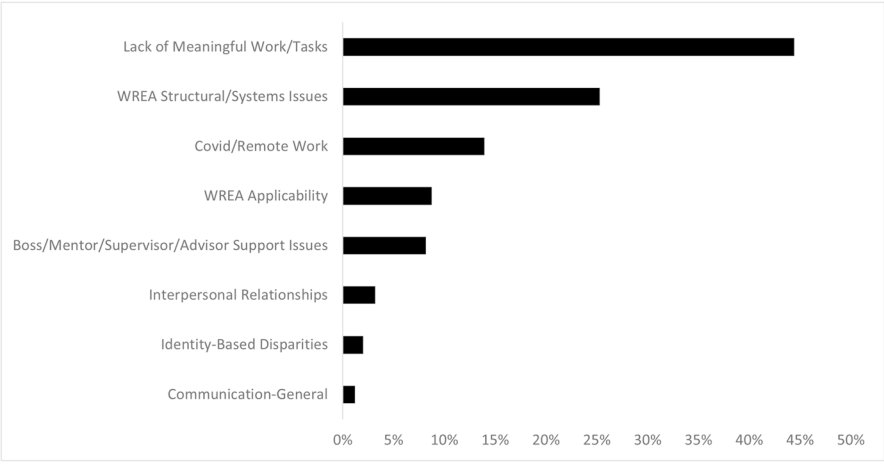
> In my specific work experience, I was able to get a lot of good hands-on experience, so I was able to gain some very technical skills with power tools

[1] 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.



Note. Responses (N=750) 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."

Fig. 1 Responses to Question: "What is the most helpful skill you developed during your WREA(s)?"



Note. Valid responses (N=502) may include multiple codes.

Fig. 2 Responses to Question: "What is the least helpful experience you had during your WREA(s)?"

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.

According to this student, they made gains in what we coded as *Communication*, *Career and Self-Development*, and *Technical Skills*.

The second open-ended 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 reported issues related to the work or 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 by 44.4% of responses. Within this group of responses, students suggested 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* was mentioned by 25.3% of respondents and included many ideas, including concerns with training 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, with 13.9% of respondents mentioning this topic. Within the *Covid/Remote* category, students suggested that Covid-19 health measures required them to report to mostly empty offices or move into remote positions. While remote, many of these students reported feeling isolated or failing to get the support or communication they desired. Other categories with limited 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.

Students who spoke at greater length provided additional insight into their experiences. For example, one response, coded as *Lack of Meaningful Work/Tasks*, highlighted a perceived issue in his/her WREA, saying:

> 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 do to remedy it.

Discussion

Career readiness is the foundation for STEM students' demonstrating requisite core knowledge and skills that set the stage for success in the workplace and lifelong career management. We acknowledge Han et al.'s (2021) findings that teachers' beliefs and teaching are strong predictors of students' self-efficacy, motivation, and academic performance, and that student STEM attitudes and STEM career awareness significantly influence their STEM knowledge and achievement (e.g., Han et al., 2021; Neher-Asylbekov & Wagner, 2023). Indeed, there is a strong interplay between the attitudes and actions of instructors and students and the resulting academic success that enables progression to a STEM career.

The NACE career competencies provide a relevant way to understand and implement future 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* administered at five universities show that many engineering and computer science students experience the positive value of work-related activities. A majority of respondents in this study completed at least one work-related experience, and more than 60% of those who participated in a WREA said they completed more than one. Based on responses, it seems clear that students understand the value of participating in work-related experiences, and many reported that they had received a job offer from the company with whom they completed a WREA. The finding that 40% of these engineering and computer science majors did not participate in a WREA is also noteworthy. Because abundant literature confirms the value of these experiential activities (e.g., Hora, 2020; Knouse & Fontenot, 2008; Margaryan et al., 2020; McGee & Spiro, 2000; Oswald-Egg & Renold, 2021), college career officials and relevant STEM faculty may wish to consider ways to encourage non-participants to engage in at least one experiential activity prior to degree completion.

Responses to survey items that mirror the NACE competencies showed that the students perceived their WREA activities to be helpful. Responses indicated that the most helpful skills developed during their WREA were related to *Professionalism* and *Communication* (mentioned by 37.9% and 35.9% 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. In addition, albeit with low correlation values, there was a significant and positive relationship between the number of WREAs taken and students' perceived value on 11 of 13 items related to career competence. Multiple similar WREA opportunities may have affected students' perceptions of benefits. For example, two or more WREAs with similar tasks may have limited the variety of skills developed, or on the other hand, multiple WREAs with similar duties could result in stronger refinement of specific skills. The desire for students to remain on time for graduation may have meant that they acquired a WREA that may not have been their desired position or that focused on the highest skills needed.

Prior literature informed us to closely examine differences by important demographic characteristics such as gender and race/ethnicity (e.g., Chang et al., 2011; Hora et al., 2021; Salmon, 2022). Our findings showed pockets of differences, but we were surprised at the relatively few findings of difference by these demographic characteristics. Findings showed a gender difference in only three items related to how WREAs helped career readiness skills. Female respondents 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 financial aid

status and only a few by race/ethnicity. The multiple mean comparisons by racial identity indicate that Black/African American students benefitted well from their WREA experiences, especially time management, compared to all peers except those of Hispanic ethnicity. Institution officials and WREA supervisors should be mindful of racial, gender, and socioeconomic differences and how they can provide a more inclusive and diverse experience. We also believe that looking outside of universities to work with industry stakeholders will prove important for improving inequality of access and experience (Hora et al., 2022).

We acknowledge that respondent perceptions vary by individual as well as based on the specific WREA location. The minimal differences found may be due to the relative homogeneity of students in these STEM majors of engineering and computer science at our participating institutions. However, since these findings contrast with recent research on underrepresented students that suggest different outcomes based on income, gender, and race (Hora et al., 2020a, c), we recommend additional studies on possible differences in the benefits of experiential activities and career outcomes by important demographic characteristics.

While some findings by demographic differences exist, more research should be done to examine the intersection of important demographics such as race and gender. We acknowledge relevant findings by scholars such as Salmon (2022). Additionally, we echo Hora et al.'s (2020c) and Blustein et al.'s (2022) 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 McDermott et al., 2022), and we are confident that WREA participation by women and other underrepresented students will help to increase self-efficacy which, in turn, will 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 specific activities and helping manage students' expectations about their WREA experience (Crain, 2016; Frenette et al., 2015; Hora et al., 2020a; McHugh, 2017; Thompson et al., 2020; Zehr & Korte, 2020). In addition, employers should ensure that supervisors offer feedback and mentorship and articulate how to appreciate the benefits of working with a diversity of peers. For WREAs that remain remote (which may be especially true for computer science tasks), 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.

Although the percentage of students who said they developed (or further developed) their skills in *Teamwork*, *Technology*, *Equity & Inclusion*, and *Leadership* was relatively small, we note that comments on these topics were made by some respondents. In line with Kolb's (1984, 2015) 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, it seems possible that WREA tasks for computer science majors might have been different from those for engineering majors. If different, certain tasks may have been better suited for a remote experience. 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 benefits by WREA modality be included in future studies.

Student success and access to WREA opportunities also include helping students find WREAs. Researchers have found that the kinds of networks that lead to WREAs may require a specific kind of cultural or social capital to access (Allen et al., 2013; Bathmaker et al., 2013; Boulton, 2015; Hora et al., 2019). Further, these barriers can compound, possibly obscuring the nature of the barriers students face to participating (Wolfgram et al., 2021). Because WREA participation has positive outcomes for students, inequities in access have severe repercussions for students unable to participate, especially those from systematically disadvantaged groups.

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 (2000) 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 (Crain, 2016; Hora et al., 2020a). For example, WREA activities that are carried out remotely need to be designed with intentionality to ensure that students receive the intended career-readiness benefits (Judene Pretti et al., 2020). Improved structures for WREA 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 (Hora et al., 2019).

In this paper, we focused on the development of career readiness skills and their assistance toward post-degree employment; however, we know that focusing only on skill 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 (Hora, 2020). 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 (Maertz et al., 2014). 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 supporting faculty supervisors who can aid in this connection (Maertz et al., 2014).

Faculty members in STEM disciplines acknowledge the value of developing a curriculum that helps students learn the important skills of critical thinking and oral and written communication. However, 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 of tomorrow. Experts who develop today's curricula must be mindful of the increasing diversity of students that enter the field (e.g., Lent et al., 2008; Lesko & Corpus, 2006; National Science Foundation, 2021), as well as additional ideas gleaned from interesting work that examines student self-efficacy (e.g., Godwin & Kirn, 2020) and motivation (e.g., Jones et al., 2010). To keep up with the rapidly changing role of the STEM worker (Tryggvason et al., 2001) that ensures the success of today's STEM graduates, academic officials may wish to complete a regular review of the curriculum and experiential activities, mindful of the students that are entering the STEM programs, as well as needs of other stakeholders including industry partners and government officials.

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Declarations

Conflict of Interest The authors declare no competing interests.

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