Understanding Experiences of Engineering Students on Faculty-Led Internship Abroad Programs

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Abstract

In recent years, engineering colleges in the United States have increasingly emphasized the cultivation of culturally-aware and globally proficient engineers. In a world that is becoming more interconnected, there is a growing demand for engineers who possess not only technical expertise, but also essential professional skills such as global awareness, effective communication across diverse groups, and adaptability. International programs, comprising study, internship, research, and service learning abroad, offer a means to nurture engineers with a global perspective. Nevertheless, engineering students often face competing priorities, such as inflexibility in curriculum and the emphasis on practical experience, which can act as barriers to their study abroad plans. International internships offer a unique opportunity for these students to attain multiple objectives by gaining international experience while simultaneously honing their professional skills. This study aims to understand the experiences of engineering students participating in a summer ten-week long faculty-led internship abroad program in Ireland. We analyzed reflection papers from four students who completed the internship program and analyzed their experiences. Preliminary findings reveal that internships abroad enhance students' adaptability, a crucial skill in the global engineering profession. Participants gained insights into navigating international workplaces, understanding diverse work dynamics, and developing skills like workplace etiquette and cross-cultural teamwork. The study emphasizes the significance of connecting these experiences to students' academic and professional goals, promoting a reflective and meaningful learning journey.

Introduction

Engineering education in the 21st century faces a distinctive challenge in adjusting to a swiftly evolving technological landscape, where ideas and innovations transcend geographical borders and distances. Numerous major technological companies in the United States maintain robust global presence across their business, research, development, and production sectors, and engineering projects and teams often collaborate across multiple countries and culture. Even though technical expertise remains crucial, engineers must possess skills such as global awareness, effective communication across diverse groups, being attuned to emerging global issues, and having the ability to adapt to a changing world in order to compete in the global arena [1], [2], [3], [4].

Study abroad has been highlighted by the U.S. Department of State as a way to prepare a diverse group of future Americans leaders to excel in a globalized economy, collaborate internationally, and enhance international diplomacy. In his first address as U.S. Secretary of State, Antony Blinken remarked that "People-to-people exchanges bring our world closer together and convey the best of America to the world, especially to its young people" [5]. The U.S. Department of Education's inaugural international education strategy in 2012 emphasized the importance of global competencies in a domestic education agenda to strengthen U.S. education and promote the nation's international priorities [6].

Many engineering educators and professionals contend that studying abroad is among the most effective methods to enhance an engineering student's global competency and to equip them for entry into a global workforce [7], [8], [9], [10]. However, the number of U.S. students who participated in an international academic experience during their time in college make up a mere 9% of all enrolled students. Meanwhile, the number of engineering students who study abroad still lags their peers in other disciplines, such as business and management, social sciences, physical sciences, and arts, according to the 2023 Open Doors Report published by the Institute of International Education (IIE) [11]. The number of engineering students who study abroad at University of Florida follows a similar trend. The gap between study abroad participation of engineering students compared to the other fields mentioned above highlights a significant disparity in international education experiences across academic disciplines (see Table 1).

Table 1 Selected Fields of Study for U.S. Study Abroad, 2021/22 (Adapted from [11])

Field of study	Participation (in %)
Business and management	21
Social sciences	18
Physical and life sciences	8
Fine or applied arts	7
Foreign language and international study	7
Engineering	6
Health professions	6
Communications and journalism	5

Engineering students face competing priorities and challenges, such as curriculum rigor, compatibility, apathy, perception of the value of international education, and an emphasis in engineering education on practical work experience, that can hinder participation in study abroad [12], [13]. High impact practices in international education such as internships, co-ops, and technical research conducted abroad has been shown to have the most significant influence on enhancing global perspectives [14]. While a relatively new aspect of international education in engineering, internships abroad offers a unique opportunity for budding engineers to attain multiple objectives in gaining international experience while simultaneously honing their professional and technical skills.

This study is derived from a larger work-in-progress looking into the experiences of University of Florida engineering students who participated in seven- to ten- week long faculty-led internship abroad programs in three international sites: Singapore, Ireland, and South Africa. In this study, faculty-led programs are defined as study abroad programs directed by a faculty member from the home institution who accompanies the students abroad and internship abroad is defined as a mode of study abroad where students engage in a professional, practical experience outside of the country in which their home university is located [15]. Internship abroad programs offer alternatives to coursework-based study abroad programs to allow students to gain professional experience within their field of study in a global setting.

The study specifically seeks to answer the following research questions related to the experiences of undergraduate engineering students who participate in a faculty-led internship abroad program in Ireland:

What are the experiences of engineering undergraduates who participate in a faculty-led internship abroad program?

For this work-in-progress paper, we provide results from reflection papers that students in one of the programs completed as one of their internship abroad assignments, offering valuable insights into their experiences and perspectives. By investigating the experiences of engineering students on internship abroad programs, we seek to understand the motivation and the impact of the programs on the students personal and professional development. In the next section, we briefly review literature to give an overview of the globalization of the engineering profession, the current state of internships abroad in engineering and other disciplines, and the impact of international experiences on engineering education. Additionally, we delve into recent studies that explore the challenges and benefits associated with internships abroad for engineering students, shedding light on the evolving landscape of globalized professional development in the field.

Literature Review

Present-day engineers should embrace a global perspective and citizenship, acknowledging their responsibility for the broader societal impact of their work. The need for engineers to not only assess their influence on the present but also contemplate how their actions might shape global society and the lives of future generations form one of the impetuses behind the development of international programs for engineering students. Emerging global trends in technology and the distribution of technology around the world has put the engineering profession at the forefront of globalization. The importance of a global perspective for engineering practice is needed to develop a deep understanding of the global market and the capacity to work in multidisciplinary, and multicultural teams with a high degree of cultural adaptability [16], [17].

In *The Engineer of 2020*, the National Academy of Engineering (NAE) highlights the fact that the accelerating global economy is tightly linked with the rapid advancement of technology across the world and "many advanced engineering designs are accomplished using virtual global teams – highly integrated engineering teams comprised of researchers located around the world. These teams often function across multiple time zones, multiple cultures, and sometimes multiple languages" [18, p. 33]. Therefore, engineering education in the U.S. needs to prepare the next generation of engineers to compete in a global market, to be able to thrive in a culturally diverse workplace, and respond to the needs of individual niches in a global environment.

Engineering education in the United States needs to use a multifaceted approach to develop globally competent engineers that goes beyond technical knowledge so that they are ready to compete in the global engineering landscape, share resources around the world to address global challenges, and advance innovation and growth to solve the world's most pressing problems. Many universities are now integrating global perspectives into the curriculum inside and outside the classrooms, such as through international programs in study, research, internship, and service learning, foreign language requirements, global engineering projects, cross-cultural courses and training, virtual exchange projects, and curriculum internationalization [9], [19], [20], [21].

The existing literature looking at the experiences of engineering students going abroad, their global competency development, and acquisition of intercultural competency [3], [22] have mostly been done through the lens of academic [23], [24], [25], research [26], [27], global design project [28], [29], and community engagement programs [30], [31], [32]. Even as engineering colleges are developing a wider spectrum of study abroad programs that offer professional and practical experiences for their students, the design of internship abroad programs has been based largely on trial and error. Very little research has been done to link program contexts to the understanding of student experiences in internship abroad programs [33].

An internship abroad involves students working directly with people in the host country in a professional setting where they must use their language, intercultural, and technical skills. At the same time, they must learn to navigate cultural differences and language barriers in both the personal and professional space. Participants in engineering internships in France reported significant learning and growth in their self-confidence, maturity, self-reliance, and social skills [34]. Students can gain technical proficiency as an apprentice as well as develop skills in global competency defined by Jesiek et al. (2014) as "those capabilities and job requirements that are uniquely or especially relevant for effective engineering practice in global context" [35, p. 3]. These attributes are unlike global competencies related to other modes of study abroad because internships emphasize the traits of a global engineer to perform on the job effectively in a local context and in their field-specific tasks. Internships abroad are likely to be an important learning experience and critical development opportunity for engineering students since working in a company requires not only technical capability but also involves social interaction within the company.

The number of students engaging in internships abroad make up a small percentage of students who studied abroad at the university studied in this paper. There is currently no nationwide data on the number of U.S. students who participated in internships abroad for academic credit as the Open Doors Report only tracked the number of U.S. students engaged in non-credit experiential activities abroad and it does not make a distinction between the types of experiential activities such as research, internships, volunteering for academic credits [11].

Commensurate with the lack of data gathering, there is very little research done on the student experiences and benefits of internships abroad for engineering students, much less so on a university sponsored faculty-led program. On the other hand, there have been many of studies conducted on internships abroad for other disciplines such as business, education, medicine, and social work [36], [37], [38], [39], [40].

Multinational companies consider global competency skills important for engineers and emphasize the need for engineers to communicate cross-culturally [41]. While career-focused experiences abroad for engineers were mentioned by employers as being the most effective way to nurture globally competent engineers [20], the gap in literature of internships abroad for engineering students is commensurate with the lack of programming in this area as most of the international programs at the university level remain academic in nature.

Internship abroad programs offer a rich training ground for college students to gain valuable international and intercultural experiences that may help close the gap between employers and

academia. The study of the student outcomes from international internship programs can bridge the divide between current programming and student needs. We hope that findings from this study will help guide university administrators and educators to develop international internship programs for engineering students with intention and purpose, as well as provide students concrete evidence to support their international education goals.

Study Design

This work-in-progress paper is part of a larger study that seeks to understand the student experiences in faculty-led internship abroad programs. The full study uses a multi-case-study approach. For this paper, we only analyzed reflection papers completed by students in one of the three programs. The participants in this study were engineering students who participated in a 10-week faculty-led internship abroad program in a Western English-speaking country in the summer of 2023.

The focus of the program was the completion of an engineering-based internship in their respective fields of study and two accompanying courses called "*Engineering in a Global Context"* that focused on cultural awareness, intercultural communication, and interpersonal skills, as well as *"Engineering Internship"* that focused on preparing the students for their international work experiences. The program was directed by a faculty member who advised the students, oversaw the internship placement prior to the start of the program, traveled to the locations with the students, and facilitated the courses in a virtual format.

Research participants were recruited from amongst the program participants through emails. A total of 24 students participated in the program. Four students volunteered for the study and shared their reflection essays. The participants profiles are summarized in Table 2.

Table 2 Profile of participants for the internship abroad program in summer 2023

Participant	Major	Year in school during internship	Previous internship experience
S1	Civil engineering	2nd	No
S2	Civil engineering	2nd	No
S3	Aerospace engineering	4th	No
S8	Computer science	3rd	Yes

The internship reflection essays were based on prompts related to their internship organization and role, challenges and lessons learned, and future impact on their career and made up 25% of their final grade in the internship course (Appendix A). The essays were graded based on the students' ability to 1) describe their internship organization and role, as well as reflect on the organizational leadership and culture; 2) thoughtfully reflect on the challenges and lessons learned while working abroad; 3) discuss the future impact of the internship abroad experience, including addressing career objectives and further learning; and 4) grammar and mechanics.

The first author thoroughly read and reviewed the essays to gain a thorough understanding of the content. She used open coding to systematically break down, examine, and label the data without preconceived categories. The purpose of open coding is to general a comprehensive list of

concepts or themes that emerge directly from the data. She used the second coding cycle to focus on structuring the data around the most prominent categories. Subsequently, she identified categories and relevant codes to formulate overarching themes [42], [43]. The coding process was iterative, and the *constant comparative analysis* approach was used to compare within and across coding levels [44], [45].

Findings

As part of the faculty-led program model, the participants were enrolled in two courses that were delivered online, in addition to a full-time internship. The course objectives for *Course A: Global Engineering*, and *Course B: Engineering Internship* were aligned to provide students with a comprehensive learning experience, combining practical engineering internships with targeted courses addressing cultural competence and communication skills. The courses provided guided modules on intercultural communication, navigating an international workplace, relating the international experience to future academic, personal, and professional goals, and fostering adaptability in diverse global settings . These modules were designed to equip engineering students with the essential skills needed to work effectively in an international professional environment.

Summaries of each participants' internship setting and roles in the companies are provided below:

1) Participant S1 participated in an internship at a company specializing in creating virtual models of city plans and works with game engines and computer software. The participant's tasks included conducting research on transportation software and solar panel simulation software, as well as taking photographs of building facades for the company's computer model update.
2) Participant S2's internship was at a consulting firm focusing on civil and structural projects. The experience involved working on diverse tasks, from flood risk assessments to structural design. The participant also participated in report writing and conducting site visits.
3) Participant S3 completed an internship at an engineering firm specializing in building gyroscopes and accelerometers for various applications. The participant worked in the process engineering department, focusing on the production line's efficiency.
4) Participant S8 worked at an engineering firm on a project in the energy solutions division. The participant's background in Computer Science allowed her to work on back-end coding and building a desktop analytics software.

Several rounds of reading and analysis of the reflection essays revealed themes related to the experiences of the participants on their internships abroad. We identified relevant quotes from the essays, arranged them according to multiple levels of codes to describe emergent themes generating codes, and categorizing the data into four main themes:

1. Career Exploration
2. Engineering Identity
3. Navigating a Global Work Environment
4. Personal Growth

Within each main theme, subthemes were identified to illustrate the nuances that were present within the overarching topics (Figure 1). The subthemes were essential for capturing the intricate details and variations within each main theme, providing a more comprehensive understanding of the participants' experiences. By identifying and exploring the subthemes, the study aimed to unveil the subtleties, complexities, and diverse aspects within the broader categories. This approach allowed for a more detailed and layered analysis, ensuring that the study considered a range of factors and dimensions within each theme, ultimately contributing to a richer and more insightful exploration of the subject.

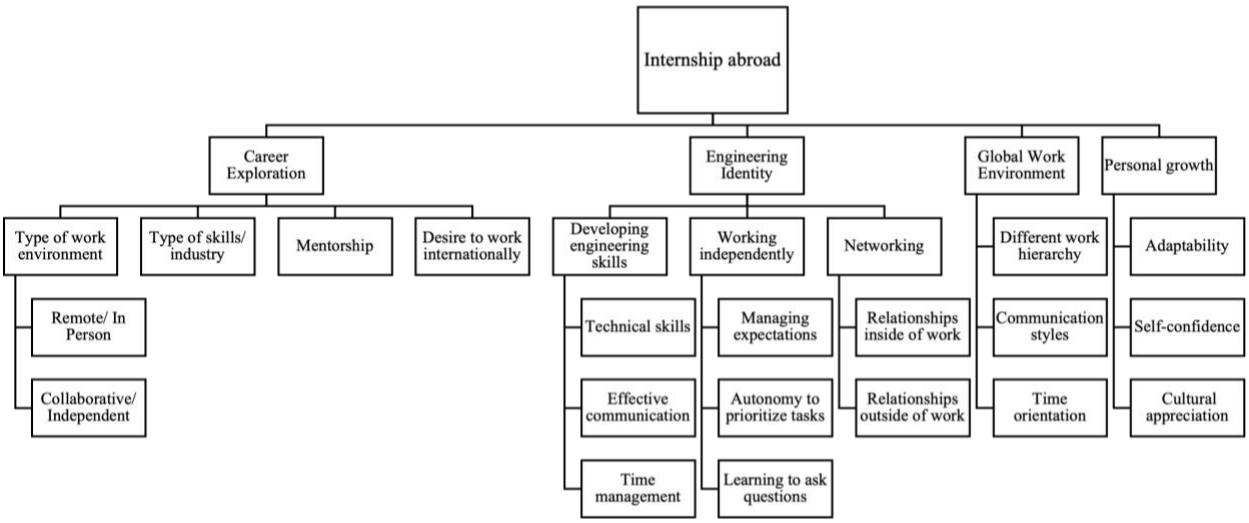

Figure 1 Themes that emerged from the analysis

Career exploration emerged as a prominent theme among all four participants. This is hardly surprising as an internship, in general, provides students the opportunity to apply the knowledge and theory learned in the classrooms in a professional work setting, gain experience, and explore career fields [46]. Participants shared that they were able to learn more about their field of study and its application in the real world, their preferences for the type of work environment and type of skills or industry. All four participants mentioned that the internship gave them motivation to explore their future career through further studies and talking to professionals in the field. Before the internship, participant S2 "wanted to go straight into the workforce as a water resources engineer", but the internship experience at a consulting firm specializing in civil and structural projects made them realize that they would instead "want to get a Master's in Structural Engineering" upon graduation. Their shift in career plans "led me to find new topics that I want to learn more about. Primarily, I want to learn about structural design and sustainable building materials". For S3, the internship gave them clarity into their future career and solidified their path forward:

> I am an Aerospace Engineering major but for the past few years, I suspected that I would like the field of systems engineering better. I knew that I could still get my degree as is and just get experience in the systems field and be able to work

> in systems engineering with aerospace applications. This internship was exactly that and proved to me that I do want to focus more on systems engineering.

Two out of the four participants emphasized the importance of mentorship in the workplace as a criteria to helping them succeed. S2 shared that "working in a place with a supportive culture that focuses on mentoring employees rather than demanding perfection" will be an important criteria in her future job search, especially looking out for intentional and organized mentorship programs available in the work environment. Similarly, S3 had a positive mentorship experience with their supervisor and "appreciated this quality [rational problem-solving] because he never caused unnecessary stress" and that they "felt comfortable asking for help". Their similar approach to problem solving, which "made it easy to communicate and learn from him" was a key component to their positive workplace experience.

A subtheme that emerged in the context of being in an internship abroad was the participants' desire to work in an international setting in some capacity in the future. Participants shared that the internship abroad experience not only influenced their desire to continue traveling abroad in the future for personal reasons, but it also prompted them to want to integrate global elements into their academic and professional career in the future. S1 remarked that "being abroad in Europe, they put a larger emphasis on sustainability which reignited my interest in how civil engineering can be used to mitigate the effect of projects on the environment" and plans to explore the topic of sustainability more by reaching out to her network, doing more research, and looking for experiences in the area.

A second theme that emerged was the development of the participants' **engineering identity** through their internship. Participants were able to build their confidence as an engineer through their internships. All four of the participants felt that they "gained independence and confidence in their ability to work as an engineer", not only by asking questions and learning to search for information, but also by applying classroom knowledge to practical engineering skills, and closing the gap in skills between theory and application. The internships helped them to strengthen their engineering identity by allowing them to hone technical skills, develop their written and verbal communication skills in a professional setting, learn to accept feedback and improve from mistakes, in addition to working independently to prioritize tasks and manage expectations of clients.

An internship abroad allowed participants to develop as an engineer while also building their ability to **navigate a global work environment**. By working in a global work environment, the participants learned to navigate a cross-cultural setting in a professional environment with different cultural dimensions. They specified that the attitudes in power distance and time orientation were the most prominent differences between their host country and the U.S. Hofstede defines power distance as "the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally"[47]. Compared to the cultural dimensions of their home country, the participants encountered a more relaxed and egalitarian power structure at work where the supervisors took into account the input of their staff into their decision making, and were generally more hands-off in their supervisory approach. Participant S1 and S8 gave examples of this work hierarchy,

> Elements of the workplace organization that were different from what I may experience in the U.S. was how hands-off my supervisor was and how he trusted me with the responsibilities I was given. Also, I got to see what other projects were being worked on some days during work instead of working on my project as this work environment was much more relaxed than what I have experienced beforehand. [S1]

> The biggest difference in organizational culture I noticed at work was power distance. At my previous internships in America, my bosses felt very powerful and far away. Here in Ireland, the space in the workplace hierarchy seemed significantly smaller. I was shocked by the low power distance in [host country's] work culture when interning in [host country]. [S3]

However, the relaxed and discussion-driven work culture was also a challenge that S1 had to learn to navigate as, "This relaxed and discussion driven work culture was something to adapt to as I had to teach myself that it was ok to take a long lunch break or to get side tracked working on other things rather than the primary task put in front of you".

The difference in attitudes related to time also featured prominently in the participants' work experience. In the host country, participants had to learn the relaxed approach to time compared to the stricter rules in the U.S. regarding punctuality. Initially, participant S8 was "surprised by the difference in perception of time. In [host country], time is a much more fluid concept, and being late is not as much of a big deal. This is very different to American working culture, where being late is considered extremely rude", but after an adjustment period, they were "able to adapt easily by changing their expectations of the job". Participant S3 prided themselves on their attention to timing but learned that

> …in [host country], they were more laid back. If a meeting started at 9:30, the participants would start entering the room at 9:30 and the meeting would start at 9:35. I initially would rush to get to the meeting on time but my mentor was never rushing and it wasn't uncommon that we, or others, would walk in after the meetings had started. I got used to not having timing being such a big factor in how people viewed you but still usually ended up getting to meetings first when I attended on my own. I thought it was nice to not have to put so much pressure on timing and not being afraid of being scolded for arriving a minute or two after the scheduled start time.

The fourth theme that emerged revolved around the participants' **personal growth**. The participants shared how they developed confidence and adaptability by being "so far out of my comfort zone" and "learned that I feel most successful when I try, fail, and try again". For S2, their experience abroad was definitely something that they hoped to incorporate into their academic career, and hoped to "bring flexibility to work in any environment and a willingness to understand how it fits in with my strengths and weaknesses". Another common subtheme that emerged as part of the participants' personal growth was appreciation for other cultures. Participants' experiences living abroad have allowed them to gain an appreciation for being in a multicultural environment and gave them the confidence to "adjust to different cultures and meet new people abroad". Additionally, there "has been a continual thread of intercultural learning" and appreciation for a diversity of views and adaptability in the workplace when "everyone

brings a unique perspective, different norms, and competing expectations for how the workplace should operate and how work is done". The participants' recognition that each individual contributes a unique viewpoint, adheres to different norms, and holds distinct expectations for workplace operations and tasks, underscores the importance of adaptability in navigating the complexities of a diverse professional environment. This recurring thread highlighted the significance of continuous intercultural learning as a valuable aspect of the participants' overall internship experiences.

Conclusion

This study is part of a larger work-in-progress study looking into the experiences of engineering students on internship abroad faculty-led programs. The findings of this study shows that internships abroad provide engineering students with the opportunity to cultivate a flexible mindset and adapt quickly when encountering new and unfamiliar situations, whether in their personal or professional environments. This is shown through the participants ability to navigate their new working environment in a different culture with a diverse group of people. This adaptability is seen as a crucial skill for success in the evolving landscape of the global engineering profession, where the ability to navigate diverse challenges is highly valued. Students learned how to navigate an international workplace, developing an understanding of the unique dynamics and expectations of various global work environments, such as workplace etiquette, cross-cultural teamwork, and understanding organizational structures in diverse settings.

The internships abroad also emphasized the importance of connecting the international experience to students' future academic, personal, and professional goals. The reflection essays encouraged students to articulate and integrate their cross-cultural experiences into their broader educational and career trajectories. This intentional linking of experiences fosters a more meaningful and impactful learning journey.

Further studies will be done to support this work by looking into faculty-led internship abroad programs in other countries using more comprehensive data gathering and analysis. We hope that future results will encourage more engineering students to pursue internships abroad as well as prompt engineering educators to integrate international work experiences into the engineering curriculum.

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Appendix A

Final Internship Feedback Form

As you approach the conclusion of your internship, please complete the Final Internship Feedback Form

This form will allow you and your industry mentor to provide written feedback regarding your experience. It is your responsibility to schedule time with your industry mentor to discuss your progress and complete your midterm and final feedback forms.

Internship Reflection Paper

This final paper will give you a chance to reflect on your internship experience and working abroad. It is expected that you will reflect and think critically about your internship experience and your time abroad and provide a thoughtful reflection. Your paper should be 3-pages minimum (double-spaced, 12 pt. font) and reflect on the following questions:

Organization & Role

- Tell me about the organization you worked for in [redacted]. Provide a summary or background information about the organization. What was your role as an intern? Did you work on any special projects?
- Who was your industry mentor/supervisor for your internship? How did this person's leadership/mentorship influence your workplace experience?
- Were there any elements of organizational culture or communication at your internship that may be different than what you might experience in the U.S.? How did you adapt to the organizational culture?

Challenges & Lessons Learned

- Did you face any challenges during your experience working abroad? These can be challenges with cross-cultural communication, a specific task, organizational culture, etc. How did you overcome these challenges?
- What lessons did you learn from your experience? About yourself, work life, etc.

Future Impact

- As a result of your experience, have your career objectives changed in any way? Explain.
- What are 2-3 things you are interested in learning more about in the industry? How are you going to seek this information?
- How can you use this intercultural work experience when you return to [redacted] and/or toward your future career goals or profession?