Foot in the Door: Developing Opportunities for Computing Undergraduates to Gain Industry Experience

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ABSTRACT

The demand for skilled workers in computing fields continues to outpace the supply of qualified students. Despite the need, hiring can be a challenging process, both for employers seeking prospective employees and for students who may be unsure where to apply, daunted by technical interviews, and/or feeling the effects of imposter phenomena. In this experience report, we describe a program established to reduce some of these hurdles by pairing (n = 63) undergraduate students with (n = 7) companies to offer short-term computing internships, called a "Sprinternship." Sprinternships eliminated the hurdle of technical interviews, provided students with training beforehand to offer foundational knowledge, and placed them in teams to work on challenge projects. We describe the details of the program and our investigation of its impact. Social Cognitive Career Theory guided the inquiry as we took a mixed-methods approach to understand the students' experiences and the potential impact on their self-efficacy, outcome expectations, and career goals. Quantitative analysis revealed a statistically significant increase in students' confidence in computing, something echoed in their open-ended responses. Thematic analysis further yielded that Sprinternships were meaningful in two major areas: Goals and Learning Experiences. The program aided in students' self-discovery, made them feel accomplished, and strengthened their industry ambitions. Responses also yielded insight into positive and negative programmatic aspects to consider for future iterations. We hope that our description of the Sprinternships, findings, and recommendations can be useful to other practitioners looking to engage students with practical learning and enhance their graduate employability.

CCS CONCEPTS

• **Social and professional topics → Computing education**.

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KEYWORDS

internships; computing careers; undergraduate students; industry experience

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1 INTRODUCTION

According to the Bureau of Labor and Statistics, the job outlook for software developers and related jobs is projected to rise by 25% between 2021 and 2031, a rate that outpaces the average rate of growth for most other occupations [3]. In a global economy where the use of technology permeates all industries, companies are forced to invest in a strong technical workforce to stay competitive, agile, and relevant in the marketplace. This is a boon for computing students who are competing for lucrative technical careers because they no longer have to target positions at purely technology-based companies. Career paths in computing and related fields have well-established pipelines for students' job placement for internships, part-time, and full-time positions. In many cases, securing internships early in students' academic careers is an important step to securing employment in the most sought-after companies [16].

Internships offer a practical and hands-on professional development opportunity where students can apply the technical concepts taught in their classes and cultivate additional competencies and professional skills [21]. Students may further critical learning opportunities in areas like teamwork, project planning, leadership, and communications skills, to name a few. Moreover, in many instances, the tools and technologies that students learn and work on during their internships are very different from what they learn from their coursework (since course curricula often tend to lag behind the latest tools used by the industry [20]). As such, learning new tools that are industry-facing makes students more competitive for internships and jobs. For computing students who graduate without having participated in an internship, studies have mentioned they may feel under-prepared for the workforce and/or may be passed over by prospective employers [10].

Although internships may be beneficial for students to gain exposure (i.e., to the workplace and distinctive tools), acquire new skills, and form connections with companies, not all students may elect to apply for such roles. Scholars have proposed multiple explanations around the lack of participation of computing students in internships, such as [8]: feelings of low self-efficacy, lack of technical preparation for internship interviews, and barriers relating to the application process itself. Studies have indicated that the lack of this critical step in preparing for a successful computing career can affect the computing identities of students, thus posing yet another barrier to entering the field [8].

Even for students that do apply, obtaining these roles can be a challenge, in particular, due to companies' predilections for technical interviews as part of the hiring process [2]. Technical interviews generally require the interviewee to solve a programming challenge on a whiteboard in real-time, often with the requirement that they talk their way through the problem. The intention of the technical interview is to understand the problem-solving approach followed by the interviewee rather than to test their knowledge of the syntax of any given programming language. Students may feel intimidated by the process and have described technical interviews as a "form of high-pressure 'whiteboard algorithm hazing' " [2, p. 16]. This interviewing system is perceived as valuing efficiency rather than one that values interviewing candidates in a more realistic, low-pressure setting. While alternative options have been proposed (e.g., take-home assignments) industry is unlikely to change the practice in the near future as it is often seen as the best way to gauge programming abilities in a short time frame.

Accordingly, we created a program designed to help students overcome some of these barriers. In this experience report, we describe our approach for undergraduate computing students, a no-interview, summer, micro-internship opportunity called a "Sprinternship." The name was derived as a contraction of the words "Sprint," a reference to the Agile software development (SD) methodology, and "Internship." Through the program, we sought to:

- **Aim 1:** Empower computing students to accept short-term positions with companies to gain practical experience
- **Aim 2:** Create opportunities for computing students to make industry connections
- **Aim 3:** Encourage students to envision the next steps they could take in their career path in computing

2 RELATED WORK

2.1 Professional Development in Computing

Professional development (PD) for computing students encompasses all experiential learning that prepares them for their future careers in the computing industry. Positive PD experiences (e.g., SD capstone courses and industry-academia partnerships) can cement students' interest and commitment to the computing field while giving them an opportunity to sample a variety of companies, technologies, and focus areas [5]. Not only can PD experiences such as internships and hackathons further shape students' professional identities, but they can also provide validation of their abilities to be successful in this field of work [7]. Furthermore, when employers engage with students through PD opportunities, they can get an early look at the talent available in the market, and internships can further facilitate their staffing plans.

2.2 Theoretical Framework

Lent et al.'s Social Cognitive Career Theory (SCCT), a framework describing how career choices are made, was used to ground the study on Sprinternship [11–14]. According to this model, the three motivators for career achievements are self-efficacy, outcome expectations, and performance goals. The theory describes that when people are given the opportunity to practice and perform tasks in a meaningful way, their sense of self-efficacy and interest in the activities increases. As a result, they may be more inclined to set greater goals for themselves and enhance their own expectations of positive outcomes. In the case of Sprinternships, students' hands-on experiences could influence how confident they felt about their ability to work in the field of computing. We applied this framework in the design of the program and the survey used in our evaluation. It also was employed in the interpretation.

3 SPRINTERNSHIPS

3.1 Overview

The goal of the Sprinternship was for undergraduate students to work together in a diverse learning environment while gaining practical experience and solving a real-world problem. We designed the program as a paid, 3-week opportunity open to all computing students at a large university in the southeast. The Sprinternships placed students in teams of 3-5 individuals at local companies, or host organizations, where they cooperatively sought to complete challenge projects posed by their employers.

Within each host organization, mentors oversaw the "Sprintern" teams or pods. The students were immersed in the culture of the organization through their everyday interactions in both large and small group settings, and given exposure to the business workings of the companies through participation in department meetings and presentations. Students were also mentored by their industry mentors at the employer sites to better prepare them for careers in the computing industry through workshops on resume building, mock interviews, and general career advising. Ultimately, the program culminated in a final presentation from the Sprintern team to a larger leadership group at the organization.

After the presentations, the host companies celebrated the success of their Sprinterns on professional social media platforms such as LinkedIn. These organizations also paid the students a stipend upon the completion of the micro-internship. In addition, the students showcased their successful experiences on their own professional social media accounts and took the opportunity to grow their professional network by "tagging" and reposting their mentors' posts.

Some unique facets of the Sprinternship model include the pairing process to connect the Sprinterns and the employers, the training of Sprinterns on technical and professional (non-technical) skills, and team building efforts to build a community of learners. These components of the program are described in detail in the sections below. We also describe the demographics related to those involved with the Sprinternships.

3.2 Recruitment and Pairing Process

Students enrolled in a computing department at the institution were informed about the opportunity through email, social media posts, information sessions (both in-person and virtual), and physical posters on campus. We requested they submit their resumes to apply, and so that we could determine their eligibility (the criteria was that students had to be undergraduates). Since the Sprinternship was designed as an opportunity to gain experience without completing any interviews, students were matched with the host companies through a process comparing the skill demands of the organization against students' self-reported skills.

Alongside recruiting students, the organizations involved in hosting students were purposefully selected by staff at our university. We reached out to target companies via email and phone to explain our planned program, its goals, and expectations. Those who were amenable then let us know their preferred capacity and agreed to provide funding (a minimum rate of $15 per hour) and mentoring for the students involved. Host companies committed to participating detailed aspects of the challenge projects that they intend to pose to their Sprintern teams along with a set of desired skills and competencies necessary to accomplish these goals.

A team of two full-time staff members collaborated to make the match decisions, and it involved multiple iterative rounds of matching skill sets requested by employers to the skills available from applicants. It must be noted that this was a complex and complicated process to handle manually because in most cases, a heuristic algorithm was the best way to match students to employers. In future implementations, the university has plans to write a matching software to automate parts of the selection/match process.

3.3 Training and Team Building

The match process for Sprinternships also gave the administrative team information on the students' knowledge deficiencies which could hinder the successful completion of their challenge projects at the employer sites (e.g., programming languages, frameworks, and technology platforms). To ensure that students were comfortable in their new roles, and to level the playing field of understanding, 24 hours of upskilling workshops were held over a 6-week period preceding the Sprinternship. The workshops were implemented and led by both undergraduate and graduate students at the university. Students further along in their studies, with advanced technical skills, provided peer training on the designated topics. Peer-led training has been shown to increase students' interest in the topics presented while also reinforcing confidence in their own abilities [9]. In addition, the program advisors helped to mentor these students with lesson planning and pedagogical topics. Anonymous feedback was solicited from workshop participants after every workshop session as a part of efforts to continuously improve the learning experience for the Sprinterns.

The upskilling workshops allowed students to meet at least 6 weeks prior to the start of their Sprinternship experience, providing them an opportunity to meet and work with their teammates in advance. Students that would be placed at the same employer sites were encouraged to sit together during these workshops, to foster a sense of community and team spirit. Students found value in sharing a sense of common purpose and goal, which was to prepare for a successful Sprinternship experience.

3.4 Participants: Students and Employers

In total, n = 57 undergraduate students participated in and completed the Sprinternship program described. 67% of the participants identified as women and the rest as men (33%). The racial and ethnic distribution of the participants is as follows: 46% Hispanic/Latinx, 19% African American, 9% Asian, and 26% chose "other".

The 57 participants were placed at 7 employer sites. They worked mostly under virtual or hybrid conditions. The employers included a major financial services company, a large data analytics company, the technology arm of a local city government entity, a regional hospital system, a career-focused university department, and 2 research labs at a R1 university.

4 EVALUATION

To better understand how the Sprinterships impacted students' goals and their learning experiences, we employed pre- and post-experience surveys and took a parallel convergent mixed method approach. The surveys consisted of closed- and open-ended questions and were administered in Qualtrics. They were disseminated via email and through Discord. While students completed the surveys on a voluntary basis, they were rewarded with a modest swag item (a university branded tee shirt) upon completion of the surveys. The study did receive Institutional Review Board approval and appropriate guidelines were followed. Below, we describe the analysis conducted and our findings.

4.1 Analysis

Quantitative Data. Closed-ended items were posed on a 5-point Likert scale that ranged from "Not at all" (0) to "Very much so" (4), using items previously validated around disciplinary identity [18, 19], and particularly their confidence/self-efficacy and their interest in computing. Data was analyzed using R Studio (2022.12.0 Build 353). For each of the closed-ended items, we first ran a Shapiro-Wilk test to check the normality of the data. Since the distribution was not normal (using a statistical significance of less than 0.05), we employed Wilcoxon Signed-Rank Tests, the non-parametric version of a paired t-test, to determine statistically significant changes in students' self-reported scores.

Qualitative Data. The open-ended questions (such as "What about the Sprinternship surprised you the most?") were analyzed using thematic analysis. Two raters independently reviewed responses to generate two separate codebooks around students' academic and career "goals" and "learning experiences." The raters developed these codebooks separately but then met to negotiate upon before coding. NVivo was used for the coding and the inter-rater agreement. They obtained a kappa coefficient of 0.88 for "Goals" and 0.81 for "Learning Experiences," which, are considered an "excellent agreement" according to Fleiss et al. [4, p. 609].

4.2 Findings

Quantitative Results. There were no significant changes in participants' opinions regarding their interest in computing, nor on their perception of their ability to learn computing topics. However,

there was a statistically significant change (p-value = 0.02) in students' confidence towards understanding computing related topics over the course of the experience. Specifically, in the ratings related to the item "Please rate the following statements as they apply to you and/or your opinions. - I am confident I can understand computing-related concepts."

Qualitative Results. We describe the results of the thematic analysis around each topic below. First, we elaborate on "goals" in Table 1. "Goals" pertained to student responses concerning targets set by students around their own learning, areas of computing that they resolved to focus on, and the effect that their organizational experience had on their plans for their careers. This analysis resulted in three codes and eight themes. The three themes identified in this category were: Self-Discovery, Academic Advancement, and Industry Ambitions.

As described by the theme of "Self-Discovery," any of the student responses spoke to the Sprinternship increasing their feelings of self-efficacy and confidence. As one student described:

> *It was a huge learning experience for me. It taught me to speak up, and how to communicate well with others. Being shy and not asking for help just hinders the success of not only you and those around you but of the company as well. I also know how to introduce myself properly and I feel so much more confident in myself.*

The program also allowed students to experience various technologies and platforms, giving them a chance to evaluate their interests and goals. Several students mentioned that the opportunity helped them to reflect on preferred modes of working and career goals. As another participant elaborated:

> *Since I was working with APIs in the Sprinternship, it made me realize that I don't necessarily have to be an iOS developer in the future and I'll be happy with and enjoy the majority of computing concepts. [...] I also realize I might not strive to be a senior developer since they are extremely busy and so my career goal might just be to be a regular developer.*

The theme of "Academic Advancement" encompasses students' plans to use the experience to further themselves or their knowledge. The responses spoke about how contact with employees and mentors in the host organization gave them insight into the varied backgrounds of those working in the field and potential career implications. They highlighted the potential to take more classes, pursue graduate degrees, or to gain additional expertise in certain technologies through self-study. As one Sprintern emphasized:

> *The Sprinternship has had a profound impact on my future academic plans. It has solidified my interest in software development and motivated me to pursue advanced coursework in this field. The practical experience and exposure to industry-relevant technologies have provided me with a strong foundation and ignited a drive to further explore and excel in my academic pursuits.*

The theme of "Industry Ambitions" spoke to how the experience opened students' eyes to corporate expectations or industry realities. In some cases, this presented as the professional skills needed or assets one could offer beyond merely technical prowess. One such comment was that:

> *I think it mostly impacted how I will proceed with the next two years that I have remaining here. I think mostly how I will grow to build as a person and expand other interests other than computer science because the degree is very skill focused but companies were asking a lot of who I was and not what I could do. There was a large understanding of learning on the job.*

Another student mentioned that:

> *It was a huge learning experience for me. It taught me to speak up, and how to communicate well with others. Being shy and not asking for help just hinders the success of not only you and those around you but of the company as well. I also know how to introduce myself properly and I feel so much more confident in myself.*

Next, we considered students' learning experiences. As illustrated in Table 2, we observed a total of three themes (Support, Challenges, and Skills Acquisition) and seven codes.

The theme of "Support" referred to assistance that students received from their peers and mentors during Sprinternship. Teammates were described as vital contributors to the overall success of the experience and projects. Participants also described instances where the support of their mentors had a tremendous impact on their learning and increased their comfort being in the learning zone. As one mentioned:

> *My team had an amazing mentor who also worked as a software developer at the host organization, and the most affirming thing he said to us was to "not be afraid of asking questions" and that he understood what we were going through since he had also been an intern a few years back.*

The theme of "Challenges" spoke to hurdles that students faced because of issues arising from team dynamics, negative attitudes from peers or industry mentors, and the struggles they faced as a direct result of their lack of experience with the tools and techniques used in their specific projects or in the industry in general. Sometimes this was presented in terms of a lack of prior knowledge about critical skills combined with a lack of timely support from peers or mentors. This led to increased stress levels and a feeling of being overwhelmed at times. As one student mentioned, "*The lack of communication with certain team members I found a little frustrating*."

It was also evident from the responses that the team dynamics were not always conducive to learning. Several students shared dealing with some problematic and discriminatory attitudes from both their peers and organizational leaders. As exemplified in the following comment:

> *It was a little frustrating to see how one of our team leaders, directed himself more towards the boys rather than the girls. When he would give advice, he would name the boys and not the girls, so it was a little uncomfortable to see that at first.*

Category	Code	Description
Self-Discovery	Motivation	Ways in which the experience bolstered their belief in themself or their abilities
	Role Clarity	Students understood what areas in computing they wanted to focus on and what they were good at, or not good at or their outlook on how they contribute to computing and have an impact
Academic Advancement	Coursework	Refers to computing topics the student(s) want to learn more about, or new classes they plan to take
	Graduate Study	Comments around students' decision to attend graduate school or not to do so
	Skill Acquisition	Depictions of additional skills or competencies students hoped to gain at their institution
Industry Ambitions	Organizational Impact	References to a specific company or things needed beyond institutions
	Career Competencies	Students described the impact of gaining skills, both technical and non-technical, that are valued by the industry.
	Relationships	Students described the impact of networking with others and its perceived benefits

Table 1: Students' responses around their "Goals"

Category	Code	Description
Support	Mentors	Times when students relied on their mentors from the organization to learn more about what was needed or to further their own growth
	Peers	Times when students relied on their teammates to learn more about what was needed, for assistance, or for collaborations that benefited the outcomes
Challenges	Team Dynamics	References interpersonal issues with those they were working with
	Attitudes	Personality traits or treatment the students struggled with or found problematic/discriminatory
	Lack of Experience	Times when the students mentioned struggling with a lack or knowledge or finding things overwhelming
Skill Acquisition	Technical Competencies	Referred to technical knowledge gained or familiarity with technical tools gained over the course of the experience, or things they want to study or further their knowledge of
	Professional Competencies	Referred to non-technical knowledge gained over the course of the experience, or things they want to study or further their knowledge of

Table 2: Students' responses around their "Learning Experiences"

Another Sprintern noted, "*There was a little bit of misogynistic attitude from one of the sprinterns on our team that was a bit frustrating but we were able to work past that.*"

The theme "Skill Aquisition" spoke to the technical and professional competencies that were gained as a direct result of the Sprinternship. Students spoke about newly acquired coding skills using programming languages as well as the competencies gained associated with understanding and applying technology tools for software version control (e.g., GitHub), project management methodologies (e.g., Agile), communication tools (e.g., Slack). As one student mentioned:

> *Overall, my learning experience at the employer site encompassed practical application of tools like GitHub and Figma and hands-on coding experience with HTML and CSS. The opportunity to create user-centered designs and contribute to training materials further enriched my skill set. I am confident that these experiences have expanded my technical capabilities and prepared me to contribute effectively to future projects and provide valuable user-centric solutions.*

4.3 Discussion

The students' responses provided insight into many beneficial aspects of the program, as well as opportunities for improvement. Quantitatively, we found that the Sprinternship experience had a statistically significant effect on self-confidence around computing topics for our participants. This was also reflected in the qualitative responses of our participants, particularly as described by the theme of "Self-Discovery." This has implications for students' persistence in the computing field because strong feelings of confidence and self-efficacy about the computing discipline have been shown to contribute to students' commitment to the field of study [7].

As described by the theme of "Industry Ambitions," the Sprinternships became a meaningful event in students' professional careers that led them to consider new directions and next steps. This is particularly salient since studies have shown that lack of self-efficacy is one of the prime reasons for students to avoid seeking internship opportunities [8]. After the Sprinternship experience, participants attained clarity on some of their immediate needs such as deciding on their coursework for the next semester as well as on long-term needs such as deciding on whether to pursue a graduate degree or enter the workforce (something also touched on by the theme of "Academic Advancements"). Other studies have reported a similar increase in student focus on academic achievement as a positive impact of industry internships [6]

We further posit that the Sprinternship model that incorporates a collaborative learning environment alongside a low-stakes (students are not graded) upskilling workshop series contributed to the

increase in self-efficacy that was self-reported by the participants [15]. As highlighted by the theme of "Skill Acquisition," students reported having an increased awareness of what to expect in the workplace and greater understanding of how to apply concepts learned over the course of the experience (including both the training and internship itself). It has been shown that peer learning models contribute positively to the learning process while helping to build a cohesive environment suitable for learning [9]. The upskilling workshops create an opportunity for students to enter their Sprinternship where they are more likely to be in the zone of proximal development, a situation that is optimal for frustration-free learning ([17]).

Researchers have suggested that internships are vital to the educational journey of computing students, and help them prepare for their post-graduation career events [6]. In addition to enhancing students' resumes with well-rounded practical experience, such experiences have proven to be valuable in attracting sought-after employers as well [1]. Another point to note is that all employers were trained to take a wider view of the Sprinternship experience, one where students could immerse themselves in the culture of the organization while being exposed to their business operations. While we did not conduct a formal evaluation from employers, anecdotally, they expressed satisfaction with the preparation that students underwent. Many companies made offers for students to return for another internship or even a full-time position.

5 CHALLENGES, LESSONS LEARNED, AND WAYS FORWARD

Although the experience offered many benefits, we also identified several challenges (something reinforced in the students' responses and the theme of the same name). For others interested in creating similar programs, we reflect on the struggles we observed and offer recommendations going forward. The key items are as follows:

- **Skills Gap**: We found a gap between the skills that students assimilate as a part of their university coursework and the those expected by employers from their Sprinterns. While most of those mentioned were technical in nature, we had to account for a gap in professional skills too. These included meeting professional standards of behavior at both in-person and virtual meetings, acceptable norms for verbal and written communication, and navigating tools of the trade such as GitHub, Slack, Asana. To resolve this we plan to incorporate training focused on professional norms and expectations for the upcoming iterations of Sprinternship.
- **Difficulty Standardizing the Sprinternship Experience**: No two organizations are similar in their culture, processes, and people. For this reason, despite our efforts to standardize the Sprinternship experience, it has been difficult to reproduce the same experience for all of our Sprinterns across organizations. We will continue to provide all employers with an easily adaptable framework that would encompass all aspects of Sprinternship: Challenge project guidelines, immersion into the business and cultural aspects of the organization, and mentoring opportunities for Sprinterns.
- **Attitudes**: We plan to address the issue caused by negative attitudes from a few of the industry mentors by being deliberate in how we train the managers and mentors who come in contact with our Sprinterns, and by incorporating training that includes topics such as inclusion and culturally relevant pedagogy. We have plans to run a one hour workshop on this topic that would be be highly encouraged for all managers who come in contact with the Sprinterns. We also plan to run an hour long session for the Sprinterns as a part of the upskilling workshop series to reinforce non-discriminatory norms of engagement in professional and personal settings.

The experience yielded some important lessons. Upskilling students on both technical and non-technical skills played a vital role in preparing students for their industry experience. We have plans to continue the program in the upcoming year, and aim to scale up the Sprinternship effort to offer greater diversity of companies and to engage twice the number of students. Accordingly, we also plan to scale up our upskilling workshop plans. The unintended positive side-effects of these anticipatory workshops is that they provide a natural avenue for students to work alongside their Sprintern peers for weeks prior to beginning at the companies. This allowed for strong ties to form between team members (something spoken more about under the theme of "Support"), thus paving the way for a more collaborative team dynamic during the Sprinternship. Something to consider, is the possible benefits of extending the training period and making it open to students not part of the program to further the possible impact on the community.

6 CONCLUSIONS

In this experience report, we described our efforts to engage students in practical learning in the field of computing through short-term internships where students did not have to go through an interview selection process. We evaluated the effect of the three-week Sprinternship on students' experiences and the potential impact on their self-efficacy, outcome expectations, and career goals in computing. The findings of our quantitative analysis demonstrated that there was a statistically significant positive effect on feelings of confidence and self-efficacy about computing topics among participants. The qualitative analysis supported this finding and also shed light on the two broad categories of student goals and learning outcomes. The Sprinterns mentioned moments of motivation, role clarity, and excitement regarding their learning experiences, leading them to establish new academic and career goals with enthusiasm. In addition, they reported feeling well-supported by their peers and mentors and spoke of many technical and non-technical areas of skill-building and growth. They also touched on the many challenges they faced and overcame regarding the attitudes and personalities of other team members and organizational mentors. We hope that other entities, organizations, and interested parties can further expand on the success of Sprinternship. It is critical to create hands-on, real-world experience opportunities for computing students so that they can learn to synthesize and apply the lessons from the classroom to practical situations. Such efforts can be instrumental in helping students to succeed, and empower them to take the next steps into their careers.

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