

CS Identity Development Interview Project

FINAL PROJECT REPORT - SIGCSE SPECIAL PROJECT (MAY '18 - DEC '19)

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PROJECT SUMMARY

The goal of this project is to understand the development of computing professional identity in undergraduate CS students by identifying the ways they get involved in CS Communities of Practice (CoPs), the amount of time they dedicate to these activities, the roles different CoPs play in shaping a student's professional computing identity, as well as the resources or skill sets these CoPs provide students to become technically competent for the job market. Some avenues that provide students access to CS CoPs included industry internships, student organizations, hackathons, job shadowing programs, technical conferences, career fairs, computing competitions, etc.

EXPECTED PROJECT OUTCOMES

1. Profiles of successful students highlighting
 - a. computing CoPs and valuable activities
 - b. student recommended resources
 - c. industry experiences
 - d. sample resumes
 - e. strategies for successfully juggling professional development activities with coursework
2. Report of findings & faculty recommendations for supporting students inside and outside of classroom

PROJECT STATUS

1. Multi-institutional study across University of Florida, Georgia Institute of Technology, and Rose-Hulman Institute of Technology.
2. 750+ students participated in a survey in Spring and Fall 2019 and 42 students were purposefully sampled for 1 hour semi-structured interviews.
3. Preliminary Analysis from Survey Data will be published in SIGCSE 2020 and ACE 2020
 - a. Amanpreet Kapoor and Christina Gardner McCune. 2020. Exploring the Participation of CS Undergraduate Students in Industry Internships. In Proceedings of 51st ACM Technical Symposium on Computer Science Education (SIGCSE '20), March 2020, Portland, OR, USA. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3328778.3366844>
 - b. Amanpreet Kapoor, and Christina Gardner McCune. 2020. Barriers to Securing Industry Internships in Computing. In Proceedings of 22nd Australasian Computing Education Conference (ACE' 20). ACM, New York, NY, USA, 10 pages. <https://doi.org/10.1145/3373165.3373181>
4. Analysis from Interview Data and Documents (Resumes) will be published in SIGCSE 2021 and 2022, ITICSE 2021, and ICER 2021. Results will be disseminated through conference presentations & workshops.

750+

CS Students responded to our survey
across three universities in the US

#42

Interviews conducted across three
universities in the US

Exploring the Participation of CS Undergraduate Students in Industry Internships

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ABSTRACT

Industry internships offer CS students an opportunity to gain authentic disciplinary experiences, evaluate self-interests, and secure future employment. However, little is empirically known about CS students' participation in industry internships and the preparation process used to successfully securing an internship. This paper presents findings from our multi-institutional study aimed at understanding the participation of CS students in industry internships as well as analyzing the differences between students who intern and those who do not. We surveyed 536 CS undergraduate students across three universities in the United States and analyzed the quantitative data using descriptive and inferential statistical methods. We used thematic analysis on the open-ended survey responses. Overall, we found that 40% of students participate in at least one internship. Demographically, equal proportions of males and females interned. However, we observed that students who have higher socioeconomic status were more likely to intern. Academically, there were no significant differences between students who intern and those who do not. However, through thematic analysis, we found differences regarding students' preparation process. Interns explicitly prepared to secure internship positions by practicing interview questions and dedicating time to career preparation. Students who do not intern were less involved in the application process or relied on coursework for securing internships. Quantitative results from the survey corroborated our qualitative findings that factors outside of coursework are influencing students' ability to secure industry internships.

CCS CONCEPTS

• **Social and professional topics** → Computing education •
Social and professional topics → Employment issues

KEYWORDS

Internship, Professional Development, Career Preparation

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1 INTRODUCTION

Internships provide students an opportunity to engage in experiential learning that enhances their intellectual, personal, professional, and ethical growth [15, 39]. In addition, industry internships enable CS students to explore computing pathways, determine likes and dislikes, develop professional skills, and build professional networks in a conducive environment [19, 22, 41]. Employers consider internships as a crucial criterion for recruitment as they provide an opportunity to evaluate potential candidates over an extended period of time in a working environment [28, 38]. However, it is a cause for concern that only 57.5% of the graduating senior CS students in our sample pursue an internship. This concern for the lack of students' participation in authentic professional experiences is further amplified by the 2018 Federal Reserve Bank of New York report which stated that 26% of the CS graduates are underemployed in the United States [37]. The latter report suggests that current CS graduates may be underprepared to secure computing jobs, further exacerbating the current challenge the US educational system is facing in satisfying the demand for computing jobs [7]. Given the role of internships in building professional skills and securing full-time employment [22, 28], it is therefore necessary to understand CS students' participation in internships. Thus, in this paper we focus on exploring 536 CS undergraduate students' participation in industry internship(s) in the United States and answer the following research questions:

RQ1. Who are the CS undergraduate students that participate in industry internships?

RQ2. How does the preparation process of CS undergraduate students who secure an internship differ from those who do not intern?

The findings from this paper have the potential to prepare CS students for securing industry internships and develop targeted support programs to increase students' competitiveness for future employment.

2 BACKGROUND

2.1 CS Undergraduate Professional Development

Employers have reported that recent CS graduates lack technical abilities, personal skills, and professional qualities [3,

12, 31]. One way to improve these skills without burdening our existing curriculum is by supplementing our degree programs with professional development activities that provide students an opportunity to develop these skills through experiential learning [24]. Research in professional development for CS undergraduate students has focused on the professional development of students through participation in capstone courses [30, 36], co-curricular activities [13], project-based courses [11], local community-service projects [10], part-time or remote internships [29], or experience in an internship or work-integrated learning program developed through industry-academia partnerships [5, 14]. However, research on professional development through CS industry internships is limited and includes inquiries on understanding the role of internships in professional identity formation [26, 40], identifying the barriers that CS students face to secure an internship [21], or exploring student experiences of participation in an internship [4, 22, 33, 41]. However, there is a lack of research that focuses on identifying the characteristics of CS students who participate in industry internships as well as student attributes that help them to secure internships.

2.2 Theoretical Framework

In this paper, our exploration into the characteristics of individuals who have been able to obtain internships and those who have not, is rooted in agency as described by Bandura's Social Cognitive Theory [1]. This theory identifies the characteristics of agentic behavior and how they shape an individual's ability to set and pursue goals. Bandura suggests that human agency has four core properties: intentionality, forethought, self-reactiveness, and self-reflectiveness [2]. Intentionality is an individual's intentional planning and strategies for achieving specific outcomes. Forethought includes temporal extension of agency and lets an individual visualize futures through cognitive representations that guide prospective actions. Agency is not limited to planning and forethinking but also includes self-reactiveness. Self-reactiveness allows an agent to "*construct appropriate courses of action*" and "*regulate*" behaviors [2]. Last, self-reflectiveness lets an individual examine their functioning meta-cognitively and make corrections accordingly for future actions [2]. Bandura states that people who develop their competencies, self-regulatory skills, and enabling beliefs in their efficacy are more successful in realizing desired futures, than those with less developed agentic resources.

We use this theory to code and interpret our qualitative and quantitative data on students' internship seeking behavior and success. We believe that securing an internship position (a desired future outcome) requires agency from a student. This agency further leads to the cognitive development of skills that are required to secure an internship. Demonstration of an individual's agency or agentic properties can be identified through proxies including students' behavior of applying for internship positions, preparing for job interviews, or building technical and professional skills that are sought by potential employers.

3 METHODS

3.1 Study Design

We designed a cross-sectional multi-institutional study based on a Concurrent Triangulation Design [8] to understand how CS students participate in internships and other professional development activities through a survey and semi-structured interviews. In this design, both qualitative and quantitative data is collected concurrently but is analyzed separately and then combined [8]. Our study was designed in Spring 2019 after a single institution pilot study in Spring 2016 [22, 23]. This study is multi-institutional and has a larger sample size (5.5x) compared to our pilot. For this paper, we focus on the analysis of our quantitative and qualitative survey data and compare CS students who interned and those who did not.

3.2 Research Sites

The survey was conducted at three universities in the United States and focused on four-year CS programs targeting students across academic standing, gender, and cultural diversity. Site A, the University of Florida is a large public research university in the Southeast and offers CS, Computer Engineering (CE), and Digital Arts and Sciences (DAS) majors through the CS department. The students can choose a major when they start college but can change it at any time. Site B, the Georgia Institute of Technology is another large public research university in the Southeast which was chosen to compare the trends at two similar types of institution. At Site B, undergraduate students can choose to major in CS or Computational Media and can specialize in a self-selected CS sub-discipline. Site C, the Rose-Hulman Institute of Technology is a small private undergraduate engineering college in the Northeast. This site was chosen to compare the trends with a different type of institutional environment. This site offers students to major in CS, International CS, or Software Engineering (SE). At all three research sites, admission in undergraduate degree programs is competitive and participation in industry internship(s) before graduation is not mandatory.

3.3 Participant Recruitment

Survey participants were recruited from Site A's CS1, CS2, software engineering, human-computer interaction, and operating system courses. The students in these courses were given 1% extra credit towards their final grade for participating. Students from Site B were recruited from a CS seminar course. They were also offered 1% extra credit. For Site C, we recruited students through a recruitment email on their department listserv. We offered gift cards to every 40th respondent at Site C and this option was also available at Site A and Site B if they chose to opt-out of extra-credit. Overall, 525 students participated for extra-credit and 11 for the chance of a gift-card.

3.4 Participants

663 students responded to our survey and completed at least 5% of the survey (Total Response Rate: 44.0% at Site A and 18.4% at Site B). From these 663 students, the following were discarded: 53 students who completed less than 80% of the survey, four graduate students enrolled in an undergraduate course, 13

students who completed the survey twice (the submission with the maximum completion time was not discarded), 56 students who were not majoring/minoring in a CS discipline, and one student who did not specify whether they interned or not. Therefore, we were left with 536 students who completed more than 80% of the survey (Average Completion Rate=99.76%). Of these 536 students, 485 were enrolled at Site A, 44 at Site B, and seven at Site C. The students comprised of 362 CS majors, 118 CE majors, 21 CS double majors, 19 CS minors, 13 DAS majors, and three SE majors. The average age of respondents was 21.07 years (SD=3.75, Min=17, Max=52). Other demographics are shown in Table 1 and Table 2.

Table 1: Academic Standing & Gender of Participants (N=536)

Academic Standing (By Year)						Gender		
1	2	3	4	5-6	Others*	M	F	Others**
31.9% n=171	19.2% n=103	28.2% n=151	14.9% n=80	4.1% n=22	1.7% n=9	74.2% n=398	25.2% n=135	0.6% n=3
*Post-baccalaureate, transfer students, or pursuing a second bachelor's.								
**Two students did not specify gender and one student identified them as agender.								

Table 2: Racial/Ethnic Identity of Participants (N=536)

White	Asian	Hispanic or Latinx	African American	Others*
45.7% n=245	26.1% n=140	19.2% n=103	6.2% n=33	2.8% n=15
*Multi-racial (5), Native Hawaiian (3), Did not specify (2), Middle Eastern (2), Iranian (1), Arab(1), and Haitian American (1)				

3.5 Data Collection

We received approval from the Institutional Review Board at Site A for a multi-institutional online survey administered over Qualtrics. On average, the students completed the survey in 37.3 minutes. The Qualtrics survey consisted of 11 sections (atmost 74 questions due to display logic): Consent, Institution, Demographics, Professional Goals, Professional Identity, Industry, Degree Experience, Social Supports, Professional Development, Suggestions, and Follow-up; and three question types: 49 multiple-choice questions (MCQs), 10 short-responses and 15 open-ended responses [21]. These questions were taken from three sources: qualitative analysis of our pilot study [20, 22, 23], NCWIT Student Experience of the Major Survey [35], and CRA Data Buddies Survey [9]. For this paper, we focused our analysis on one open-ended question from the Industry section and eight quantitative factors from the Demographics and Professional Development sections. These factors were chosen based on findings from our qualitative analysis.

3.6 Data Analysis

3.6.1 Qualitative Data

We analyzed open-ended student responses using thematic analysis based on an inductive approach [34] in Microsoft Excel to answer RQ2. We started with the raw data and created codes inductively using words from participant responses. The first author created primary codes which were then clustered to form categories, and these categories were combined into themes. The authors discussed the themes in which there was disagreement until a consensus was reached about the theme accuracy and reliability. The data were then recoded. This was followed by a frequency analysis of unique participant responses within each

theme. Some participants' responses belong to more than one theme and thus the percentages do not add up to 100%.

Regarding the positioning of authors to internships, the first author worked as an intern during their CS graduate school and has worked for multiple years in the software industry after graduation. The second author did four internships during their CS degree programs. Both authors believe that participating in internships have value in gaining employment and to secure internships one needs to take active steps outside of coursework. This position might have influenced the coding process.

3.6.2 Quantitative Data

We used descriptive and inferential statistics to answer RQ1 and RQ2. The quantitative analysis was limited to the multiple-choice questions and was conducted in IBM SPSS 11. We divided the data set into two groups: students who did not intern and students who interned or were interning the summer following the study for the first time. The students who interned or were interning the summer following the study were merged into one group as we are trying to understand students' ability to secure an industry internship and what makes them different than those who do not secure an internship. We ran two types of statistical tests based on the type of variable to assess statistical significance and we also report practical significance through the appropriate effect size measure. We used $p \leq 0.05$, $\alpha = 5\%$ to reject our corresponding null hypothesis. Also, when conducting tests, we excluded extreme groups (e.g. Other genders, $n=3$) as we did not have adequate representation for that level of the nominal variable. We used the following tests:

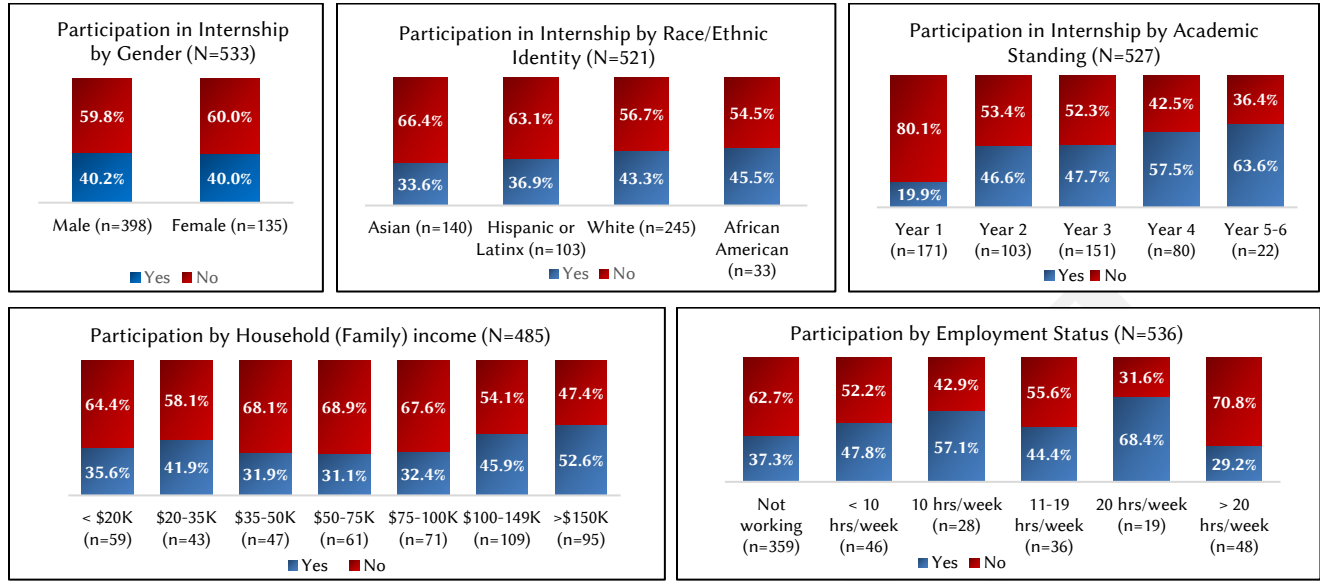
1. Chi-square test of independence (both nominal variables): to determine if there is an association between our nominal variable, Participation in internships, and another nominal variable. The null hypothesis for the test assumes there is no association between the two variables. For example, to understand if Participation in internships is associated with Gender, we conducted this test. We further describe the strength of our associations by reporting Cramer's V coefficient (range 0-1) for our statistically significant results. Cohen suggested that the magnitude of effect size for Cramer's V can belong to three categories: small=0.10, medium=0.30, and large=0.50 [6].

2. Two samples Mann-Whitney U two-tailed test (one nominal, one ordinal/interval): to assess if the samples of an ordinal/interval variable of interest for our two groups came from similar or different populations. The test has the null hypothesis that the distribution of both population distributions is similar. For example, this test was used to determine if the distribution of students' Household income for our two groups, students who interned and those who did not, came from similar or different populations of CS undergraduate students. We further describe the effect size reporting eta square (η^2) [18, 32].

4 FINDINGS

Of the 536 students in our sample, 40.1% of the students ($n=215$) interned during their undergraduate studies or were hired into internships in the summer following the study for the first time. Specifically, 22.9% of the 536 students interned previously ($n=123$) and 17.2% of the 536 students were interning

Figure 1. Demographics of Students who participate and do not participate in Internship



the summer following the study for the first time (n=92). The other 59.9% specified that they had never interned (n=321).

37.7% students at Site A (n=183), 56.8% students at Site B (n=25) and 100% students at Site C (n=7) secured an internship. In the analysis, we only consider internship participation during the 4+ years in CS degree programs. The internships ranged from working at local companies or startups such as Gainesville Regional Utilities and Airbnb to established corporations like Google and Amazon. The roles in which the students interned were eclectic and spanned various subdisciplines of computing including software engineering, user experience design, and data science. For this paper, we do not report in detail the job roles and the type of internships given the space constraints.

4.1 Demographics of interns (RQ1)

We analyzed student responses across five demographic variables and a variable, Participation in internships, with two levels, 'Yes' and 'No'. The former level consisted of both students who interned or who were interning the summer following our study. Our five demographic variables were: Gender, Race/Ethnicity, Academic standing, Household (family) income, and Employment status. These factors helped us in answering RQ1. *Who are the CS undergraduate students that participate in industry internships?* We report our findings through a graphical representation of the demographics (see Figure 1) and tabular representation of the statistical results (see Table 3).

We found that participation in an internship did not differ significantly by Gender (see Figure 1 and Table 3). Thus, we failed to reject the null hypothesis: Participation in internships is associated with Gender. Regarding Race/Ethnicity, 45.5% of the 33 African Americans students and 43.3% of the 245 White students reported that they interned which were higher than the total number of students who interned (40.1%). 36.9% of the 103 Hispanic or Latinx students and 33.6% of the 140 Asian students interned, which were lower than the aggregated number of

interns across our sample. The results across racial/ethnic identity were also not statistically significant (see Table 3).

The percentage of students who participated in at least one internship or were interning the summer following the study increased across Academic standing in our sample. 19.9% of the freshmen interned/were interning the following summer compared to 46.6% sophomores, 47.7% juniors, 57.5% seniors, and 63.6% Year 5-6 students. The results were statistically significant when conducting the Mann Whitney U test ($z = -6.63$, $p < 0.001$). η^2 , a measure for the strength of association, was found to be 0.083 which is categorized as a medium effect by Cohen [6, 32]. For Household (family) income, which is a metric commonly used for socioeconomic status, we observed that students who reported higher Household income were more likely to pursue internships compared to those who had a lower Household income (see Figure 1). Further, participation in internships across reported Household income was statistically significant ($\alpha = 0.5$) when conducting Mann Whitney U test ($z = -2.76$, $p = 0.006$). Effect size (η^2) was found to be 0.016 which is categorized as a small effect by Cohen [6, 32].

Table 3. Statistical Tests for Participation in Internship

Demographic*	Statistical Significance			Effect Size
	χ^2	df	p-value	Cramer's V
Gender (N=533)	0.00 [#]	1	1.000	0.002
Race/Ethnicity (N=521)	4.29	3	0.230	0.091
Demographic	z		p-value	η^2
Academic standing (N=527)	-6.63		0.000	0.083
Household income (N=485)	-2.76		0.006	0.016
Employment Status (N=536)	-1.46		0.140	0.004

*marginal group omitted for small numbers; [#]continuity correction for 2x2 tables

Finally, for our last demographic variable, Employment status, we saw that two-thirds of students in our sample (359 of 536 students) reported that they do not work along with their degree program while the other one third of students in our

sample worked anywhere from less than 10 hours/week to greater than 20 hours/week. Based on disaggregation of our dataset using Employment status, the results were not statistically significant when conducting Mann Whitney U test.

4.2 Preparation process to secure internship (RQ2)

Our second research question focused on analyzing the differences between students who intern and those who do not through the lens of their preparation and participation in the application process. 486 students responded to a question in our survey: “How did you prepare or how are you preparing to get an internship?”. We used thematic analysis to code their responses which led to 893 codes, 72 unique codes, and seven categories. Four themes emerged from these categories for students’ preparation process. We first describe these themes and then compare the students who interned and those who did not within each theme. We also use quantitative data from our survey to explore and triangulate the relationships between our qualitative findings and quantitative results.

4.2.1 Engagement in the Application Process

45.7% of the 486 student responses that fell in this theme (n=222) described how students were preparing for internships or previously secured an internship position by actively engaging in the application process. They created resumes or cover letters, reported the application avenues which included online applications or attending career fairs, and stated strategies they are using to secure an internship position. These strategies included applying early, applying to a large number of companies, networking with employers, dedicating specific time along with coursework for career preparation, taking advantage of connections (e.g. family), speaking to employers who were less desirable to develop interview skills, taking unpaid internships to gain experience, using a well-developed LinkedIn profile to contact recruiters, researching a company before applying, and receiving mentoring from seniors, family, university career centers, or peers who secured internships. A representative quote from a student belonging to this theme:

“Since freshman year, I have been very career-focused. I have attended career showcase & CDW [Career Development Workshop] every semester. Furthermore, before my first internship, I attended workshops and visited the Career Resources Center several times before I felt prepared (resume & interview-wise) for employment.”

- P368, Senior Female, interned

4.2.2 Skill Building

Within this theme, 44.9% of the 486 students (n=218) described that they are building technical and professional skills by getting involved outside of coursework to prepare for securing an internship position. The involvement outside of coursework covered a variety of activities or avenues including personal projects, clubs/student organizations, conferences, game jams, hackathons, team projects, study abroad programs, ethical hacking, boot camps, certifications, research labs, online courses, and gaining leadership experiences. Students stated that they are developing technical skills such as learning programming languages and web frameworks; social skills; professional skills

such as communication and networking; and interviewing skills by participating in avenues outside of coursework. Seven students also reported that they were taking useful courses to build technical skills and secure an internship. Students were developing these skills for three reasons: to explore computing disciplines, show employers their involvement, and to gain competencies in a specific skill due to self-interest.

“I’ve been preparing since late 2017 by attending UFSIT [cyber security] club meetings, taking cybersecurity classes, participating in ethical hacking events.”

-P239, Senior Male, interned

4.2.3 Explicit Interview Preparation

In this theme, 27.4% of the 486 students (n=133) stated that they secured an internship or are preparing to secure an internship by practicing technical interview programming problems on websites like LeetCode [25], GeeksforGeeks [16], and HackerRank [17], developing interviewing skills, studying data structures and algorithms, and reading books of which “Cracking the Coding Interview” [27] was the most prominent. Students reported they started using these resources after previous unsuccessful experiences in securing an internship position, or suggestions from recruiters, friends, or previous interns.

“I read books such as Cracking the Coding Interview, practiced LeetCode problems online, and worked through a couple of problems with friends. I went to resume reviews hosted by a club I am active with and went to information sessions on campus to find opportunities.”

- P426, Junior Female, interned

4.2.4 Status quo: relying on coursework or no preparation

In our final theme, 23% of the 486 students (n=112) reported that they were not preparing for internship positions, rather they were relying on coursework to prepare them for interviews, or wanted to focus on securing a good GPA which they believed would lead to a subsequent internship position. Students also stated in this theme that they were not preparing due to lack of interest or for not having time to manage the preparation process with coursework.

“Making sure my grades are impressive and taking as much away (e.g. skills and knowledge) from my classes as possible.”

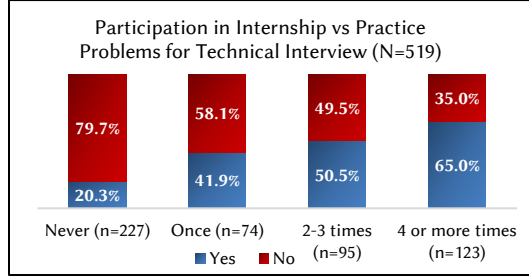
- P154, Sophomore Male, did not intern

4.2.5 Comparing the preparation process

We found that a higher percentage of interns (36.8% of the 190 students, n=70) belonged to the Explicit Interview Preparation theme when compared to students who did not intern (21.3% of the 296 students, n=63) who did not intern - a difference of 15.5 percentage points, $\chi^2(1, N=486) = 14.09, p < 0.001$. This finding is corroborated by two quantitative questions we asked in our survey. The first question focused on the time CS students devote to career development and the second asked their involvement in practicing technical interview questions. We found that the median number of hours that the interns spent on career preparation outside of coursework were two to three hours per week compared to one hour per week by students who do not intern. The group differences were statistically significant when we conducted the Mann Whitney U test ($z = -4.40, p < 0.001, \eta^2 = 0.04$). The effect size was 0.04, which is categorized as a small

to medium effect by Cohen [6, 32]. The second quantitative question, students' involvement in practicing technical interview questions was also statistically significant when we conducted the Mann Whitney U test ($z=-8.57$, $p < 0.001$, $\eta^2=0.14$). The effect size was 0.14 which is categorized as a large effect [6, 32]. We observed that those who regularly practiced or were familiar with technical interview questions on platforms such as LeetCode and HackerRank were three times as likely to secure an internship, compared with those who never practiced them - a percentage difference of 44.7 percentage points (see Figure 2).

Figure 2. Practicing technical interview problems



For another theme, Status-quo, we found students who do not intern (28.7%) were higher in this theme compared to the students who interned (14.2%): χ^2 (1, $N=486$) = 13.73, $p < 0.001$. Thus, students who did not intern were relying on coursework, focusing on getting a high GPA to secure an internship, or were not preparing for internships. We examined whether GPA is a factor to secure internships, but the results were not statistically significant when conducting the Mann Whitney U test ($z = -0.29$, $p=0.77$, $N=504$). The mean GPA for students who interned was 3.47 compared to 3.44 for the students who did not intern. We conducted the Mann Whitney U test instead of an Independent Samples t-test as the GPA data did not follow the normal distribution. We also conducted an in-depth analysis of why the students were not preparing to secure internships and report our findings in a separate paper [21].

Finally, the students who interned (51.6% of the 190, $n=98$) were more likely to engage in the application process when compared to students who did not intern (41.9% of the 296, $n=124$). The results were statistically significant, χ^2 (1, $N=486$) = 4.38, $p=0.036$. Responses falling in the Skill Building theme were independent of participation in internships.

5 DISCUSSION & CONCLUSION

We found that 40% of CS students in our sample participated in one or more internships. 57.5% of the CS students who were in their senior year participated in an internship. The percentage is similar to a national survey across different majors which found 61% of the students interned before graduation [28]. We also found that students belonging to lower socioeconomic status were significantly less likely to intern when compared with those who had higher socioeconomic status. Regarding CS students' preparation process for securing an internship, we found students who interned were more likely to be engaged in the application process and were using technical interview preparation websites more often when compared with students who do not intern. Similar to the study by McCartney and

Sanders [26], students stated the importance of reviewing Data Structures and Algorithms for the internship preparation process. Our students, however, were learning these skills through technical interview preparation on online interview preparation websites in addition to coursework. We also found that students are building professional and technical skills through their involvement in informal activities such as hackathons and projects. These avenues provided students an opportunity to develop the skills which employers report are deficient in recent CS graduates [3, 31].

Within the context of Bandura's properties for human agency [2], we observed that interns were more likely to be intentional in their approaches regarding application process as they used strategies such as networking, applying through career fairs, and devoting time for career preparation outside of coursework. Interns were also highly self-reactive as they participated in activities for professional development and regulated their behavior after receiving advice from a mentor. The students who did not intern were more likely to rely on coursework, were not preparing to secure internship positions or were spending minimal time on career preparation outside of coursework. These students were more likely to lack intentionality or forethought about industry expectations given that they relied on coursework or their high GPA for securing an internship. Students who were not applying for internships also lacked the mechanisms to self-reflect as they were not participating in the job recruitment process. Interns, on the other hand, were self-reflecting on the ways to improve their ability to secure internships after failures in the interview process or after advice they received from the recruiters. To conclude, some students who were not interns lacked agentic resources that hindered their abilities to secure internships. This leads to a question: How can we prepare such students to participate in internships or other professional development activities so that they have the necessary skills to thrive in the job recruitment process?

6 LIMITATIONS

Our findings represent a snapshot of the internship experiences taken from a sample of CS students at three US-based universities. Our sample at Site B and Site C were relatively smaller than Site A. We did not offer students extra-credit for participation at Site C and we collaborated with one instructor for extra-credit at Site B. The number of students at Site B and Site C who interned may not be representative of the population of students enrolled at the respective sites given the small sample and should be interpreted with caution. However, the internships pursued by the students were industry internships rather than research interventions. Thus, our findings should generalize to CS undergraduate students who intern in the industry in the US. We also had a lower sample of certain groups such as Females and African Americans, but such samples were proportional to the respective proportions at the individual universities. We suggest the readers not to make causal inferences from our quantitative results as our study is an observational inquiry. Finally, we attempt to address the validity of our qualitative inquiry through the transparency of our research process and recognizing the researchers' positionality.

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Barriers to Securing Industry Internships in Computing

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ABSTRACT

Industry internships offer CS students an opportunity to explore computing disciplines, evaluate self-interests, understand professional expectations, and secure future employment. However, less than 60% of CS students pursue an internship before graduation. We have a limited knowledge of why students do not participate in industry internships and the impediments they face to secure an internship position. This paper presents findings from our multi-institutional study aimed at understanding the barriers CS students face to secure an industry internship. We discuss these barriers through the lens of agency from Bandura's Social Cognitive Theory and the Social Cognitive Career Theory. We surveyed 302 CS undergraduate students who did not intern across two universities in the United States and used thematic analysis on the open-ended survey responses. We found four themes: low self-efficacy, actions, alternate priority, and application process challenges. These themes suggest that CS students who do not intern self-evaluate them as not qualified, are applying but not securing an internship position due to lack of preparation or reliance on coursework, lack the knowledge pertinent to the internship recruitment process, and are not applying for internship positions due to alternate priorities or less developed agentic resources. This paper contributes to the fields' growing knowledge of CS students professional development. This knowledge has the potential to develop strategic support programs to increase students' competitiveness to secure internships as well as full-time employment.

CCS CONCEPTS

• **Social and professional topics** → Professional topics • **Social and professional topics** → Computing education • **Social and professional topics** → Employment issues

KEYWORDS

Internship, Professional Development, Computer Science Education, Undergraduates, Career Preparation

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1 INTRODUCTION

Jobs in computing are projected to grow at 13% annually over the next decade in the United States [41]. This growth is widening the gap between the number of computing jobs available in the industry and CS graduates required to fill these jobs [42]. The rising enrollments in computing majors [10] have ameliorated the situation to a certain extent, but the demand for CS graduates is outpacing the number of enrolments in the computing majors. Moreover, it is a cause for concern that recent CS graduates might be underprepared for jobs in the industry as the underemployment rates for computing jobs held at 26% in 2018 [43]. This under preparation further exacerbates the existing gap between the supply and demand of potential computing hires. In lieu of this under-preparedness, employers have noted that recent CS graduates lack technical competence and professional skills for pertinent jobs in the industry [6,34]. One reason that the students lack these competencies is due to inadequate professional development during the 4+ years they spend in the computing degree programs. Studies have shown that less than 61% students of the graduating seniors in the United States pursue at least one internship before graduation [29], a key mechanism by which our students undergo professional development. These numbers are consistent with our sample which suggests that 57.5% of the graduating senior CS students pursue an internship [22]. While research suggests that internships play a crucial role in gaining authentic experiences through experiential learning [18], building skills [19,40], and gaining future employment [9,29,44,45], less is known about why some of our students never participate in internships.

In this paper, we focus on exploring the barriers that 302 CS undergraduate students face to secure an industry internship in the United States and answer the following research question: *What barriers do CS undergraduate students, who do not intern, encounter in securing an industry internship?* These barriers are explored through CS undergraduate students' experiences during the degree program, personal characteristics, and career preparation process. The findings from our study have the potential to develop targeted support programs to help our students for securing internships as well as increase CS students' competitiveness to secure full-time employment.

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2 BACKGROUND

2.1 Existing Research in CS Undergraduate Professional Development

Research in professional development for CS undergraduate students has focused on the professional development of students through participation in capstone courses [33,37,39], co-curricular activities [16], project-based courses [14], local community-service projects [13], part-time or remote internships [31], student experiences in industry internships [22,40], or work-integrated learning programs developed through industry-academia partnerships [11,15,17,32]. This research includes Parker's study which found that software engineering capstone courses allowed CS students to explore CS career options [33]. In another study, Fryling et al. found that a department-scaffolded internship program at Siena College had a positive impact on CS students' retention [17]. Research on professional development through CS industry internships is limited, however. This research includes inquiries on understanding the role of internships in professional identity formation [23,26,38] or exploring students' experiences of participation in an internship [8,22,35,40]. However, there is a lack of research in the CS education literature that focuses on gaining insights into why our students are not participating in internships as well as the barriers they face to secure these internship positions.

2.2 Theoretical Framework

In this paper, our exploration into the characteristics of individuals who have not been able to obtain internships is rooted in agency as described by Bandura's Social Cognitive Theory [1] and Lent et al.'s Social Cognitive Career Theory [25] which builds on Bandura's theory. These theories identify the characteristics of agentic behavior and how they shape an individual's ability to set and pursue goals and achieve their career aspirations. We use these theories to code and interpret our qualitative data on students' internship seeking behaviors and success.

2.2.1 Self-efficacy and Agency - Bandura's Social Cognitive Theory

Self-efficacy is the belief that one has about their capacity for specific achievements, given domain-specific obstacles [2]. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Contrary to self-efficacy which expresses an individual's perception, agency illustrates an individual's actual ability to deal with a complex task. Bandura's Social Cognitive Theory suggests that human agency has four core properties: intentionality, forethought, self-reactiveness, and self-reflectiveness [3]. Intentionality is an individual's intentional planning and strategies for achieving specific outcomes. Forethought includes the temporal extension of agency and lets an individual visualize futures through cognitive representations that further guide their prospective actions. Agency is not limited to planning and forethinking but also includes self-reactiveness. Self-reactiveness instantiates an agent to "*construct appropriate courses of action*" and "*regulate*" appropriate behaviors [3]. Last, self-reflectiveness lets an

individual examine their functioning meta-cognitively and make corrections accordingly for future actions. Bandura states that people who develop their competencies, self-regulatory skills, and enabling beliefs in their efficacy are more successful in realizing desired futures than those with less developed agentic resources [3].

We believe that securing an internship position (a desired future outcome) requires intentionality, high self-efficacy, and agency from a student. This agency further leads to the cognitive development of skills that are required to secure an internship. Demonstration of an individual's agency or agentic properties can be identified through proxies including students' behavior of applying for internship positions, preparation for job interviews, or students' agency to develop technical and professional skills that are sought by employers. Thus, students who are not securing internships may lack forethought, intentionality, or other agentic resources.

2.2.2 Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) models and explains the three primary mechanisms that promote career exploration and attainment [7]: self-efficacy, outcome expectations, and performance goals [25]. In particular, an individual's interest in career-relevant activities is directly related to their self-efficacy and outcome expectations. SCCT posits that in order for an individual to form a sense of efficacy and to acquire outcome expectations about their engagement in career-relevant activities, they need continued exposure, practice, and feedback on their performance in these activities. Such extended engagement enables individuals to refine their skills and helps them to develop personal performance standards and goals [25]. SCCT further suggests that for interests to develop, individuals must be exposed to the types of "*direct, vicarious, and persuasive*" experiences that can give rise to and reinforce efficacy beliefs and positive outcome expectations [25].

Thus, people are likely to form a lasting interest in activities when they view themselves as competent and when they expect that they will produce valued outcomes. Without such experiences, regardless of their level of skills, talent, and interest, SCCT suggests that individuals do not have the opportunity to form strong self-efficacy and positive outcome beliefs. As one might expect, individuals' interests in activities are unlikely to develop when individuals doubt their competence and expect negative outcomes. As a result, individuals who do not have the opportunity to reinforce their skills, experience impeded career exploration and attainment. Moreover, as individuals engage in the process of career exploration and skill development, they also encounter obstacles e.g., financial, cultural, systemic, or have varying levels of support from influential others [25]. Thus, personal agency is necessary to help individuals form performance goals that stretch the individual beyond their perceived abilities and that provide motivation to overcome common obstacles and barriers inherent in skill development, career exploration, and career attainment.

3 METHODS

3.1 Study Design

We designed a cross-sectional multi-institutional study based on a Concurrent Triangulation Design [12] to understand how CS students participate in internships and other professional development activities through a survey and semi-structured interviews. In this design, both qualitative and quantitative data are collected concurrently but are analyzed separately and then combined [12]. Our study was designed in Spring 2019 after a pilot study in Spring 2016 [20,22]. This study is multi-institutional and has a larger sample size (5.5x) compared to our pilot. For this paper, we focus our analysis on the qualitative survey data and report our findings on the barriers faced by 302 CS undergraduate students who did not pursue an internship. This qualitative data was not collected in our pilot study but was relevant for collection in this study based on the emergence of new research questions from our previous analysis [20–22]. We address the following research question in this paper: *What barriers do CS undergraduate students, who do not intern, encounter in securing an industry internship?*

3.2 Research Sites

The survey was conducted at two universities in the United States and focused on four-year CS programs targeting students across academic standing, gender, and cultural diversity. Site A, the University of Florida, is a large public research university in the Southeast and offers CS, Computer Engineering (CE), and Digital Arts and Sciences (DAS) majors through the CS department. The students can choose a major when they start college but can change it at any time. Site B, the Georgia Institute of Technology, is another large public research university in the Southeast which was chosen to compare the trends at two similar types of institution. At Site B, undergraduate students can choose to major in CS or Computational Media and can specialize in a self-selected CS sub-discipline. Admission to both sites is competitive and internships at both sites are not required for graduation.

3.3 Participant Recruitment

Survey participants were recruited from Site A's CS1, CS2, software engineering, human-computer interaction, and operating system courses. The students in these courses were given 1% extra credit towards their final grade for participating based on pre-approval by the course instructors. Students from Site B were recruited from a CS seminar course. They were also offered 1% extra credit. We also offered gift cards to every 40th respondent at Site A and Site B if they chose to opt-out of extra-credit. Overall, 299 students participated for extra-credit and three for a chance to obtain a gift-card.

3.4 Participants

654 students responded to our survey and completed at least 5% (Total Response Rate: 44.0% at Site A and 18.4% at Site B). From these 654 students, the following were discarded: 51 students who completed less than 80%, four students who were graduate students enrolled in an undergraduate course, 13

students who completed the survey twice for two different courses (the submission with the maximum completion time was not discarded), 56 students who were not majoring/minoring in a CS discipline, and one student who did not specify whether they interned or not. Therefore, we were left with 529 students who completed more than 80% of the survey (Average Completion Rate=99.8%). Of these 529 students, 60.7% of the CS undergraduate students (n=321) reported that they never interned during their undergraduate studies or were not hired by an employer the summer following our study for an internship. Specifically, 62.3% of the 485 students at Site A (n=302) and 43.2% of the 44 students at Site B (n=19) did not intern. The remaining 208 students at the two institutions previously interned or were interning the summer following our study. These 208 students were also excluded as they are not relevant for answering our research question. Further, 19 of the 321 students who did not intern were excluded as they did not respond to the qualitative question on our survey. Thus, we were left with 302 CS undergraduate students who never participated in an industry internship and answered the pertinent questions in our survey.

Of these 302 students, 285 students were enrolled at Site A and 17 at Site B. 276 were full-time students, 22 were part-time, three were post-baccalaureate, and one an exchange student. The students comprised of: 207 CS majors, 65 CE majors, 10 DAS majors, 10 CS minors, nine CS double majors, and one unspecified major. The average age of respondents was 21.1 years (SD=4.1, Min=17, Max=43). The average GPA of respondents was 3.44 on a scale of 4.00 (SD=0.47, Min=1.40, Max=4.00). Other demographics are shown in Table 1 and Table 2.

Table 1: Academic Standing[†] & Gender Identity of Participants (N=302)

Academic Standing (Year) [†]						Gender		
1	2	3	4	5-6	Others*	M	F	Others**
43.1% n=130	17.2% n=52	23.2% n=70	11.3% n=34	2.6% n=8	2.6% n=8	73.8% n=223	25.5% n=77	0.7% n=2
*Post-baccalaureate, transfer students, or pursuing a second bachelor's.								
**One student did not specify gender and one student identified them as agender.								

Table 2: Racial/Ethnic Identity of Participants (N=302)

White	Asian	Hispanic or Latinx	African American	Others*
43.0% n=130	29.5% n=89	20.2% n=61	5.6% n=17	1.7% n=5
*Multi-racial (1), Native Hawaiian (1), Middle Eastern (1), Arab (1), and Did not specify (1).				

3.5 Data Collection

We gained consent from the Institutional Review Board at Site A for a multi-institutional online survey administered over Qualtrics. On average, the students completed the survey in 37.3 minutes. The survey consisted of 11 sections (maximum of 74 questions due to display logic): Consent, Institution and Extra-credit, Demographics, Professional Goals, Professional Identity,

[†] In the United States, students' academic standing in an undergraduate degree program refers to the year they are in the degree program which corresponds to Year 1 (freshman), Year 2 (sophomore), Year 3 (junior), Year 4 (senior), and Year 5-6 (super-senior).

Industry, Degree Experience, Social Supports, Professional Development, Advice and Suggestions, and Documents and Follow-up. These 74 questions were of three types: 49 multiple-choice questions (MCQs), 10 short-response questions, and 15 open-ended responses. These questions were taken from three sources: our qualitative analysis of pilot study [20–22], NCWIT Student Experience of the Major Survey [30], and CRA Data Buddies Survey [46]. For this paper, we focused our analysis on one open-ended question from the Industry section and quantitative factors from the demographics section to describe the context. The open-ended question in the survey that we use for our analysis was: *Why haven't you interned so far?* and this question was displayed to students who selected that they had not interned previously or were not participating in an internship the summer following our study.

3.6 Qualitative Data Analysis

We analyzed student responses to our open-ended question using thematic analysis based on grounded theory [36] in Microsoft Excel. We started with the raw data and created codes inductively using words from participant responses. The first author created primary codes which were then clustered to form categories, and these categories formed the basis of our codebook. The categories were merged to form the themes and the authors discussed the themes in which there was a disagreement until a consensus was reached about the theme accuracy and reliability. Then the data were recoded. This was followed by a frequency analysis of responses within each theme. We counted unique participants when computing these frequencies, to avoid counting multiple responses from the same participant within any theme. Some participants' responses belonged to more than one theme and thus the percentages don't add up to 100%.

3.7 Author Positionality

Regarding the positioning of authors to internships, the first author pursued an internship during their CS graduate school and have worked for multiple years in the tech industry after graduation. The second author pursued four internships during their undergraduate and graduate CS program and is currently an Assistant Professor at Site A. Both authors believe that pursuing internships have value in gaining employment and to secure an internship, one needs to take active steps outside of coursework. This position might have influenced the qualitative coding process.

3.8 Industry Internships in the United States and Hiring Context

Students can apply for internship positions in various computing disciplines including software engineering, web development, user experience design, data science, and computer networks. These positions include co-op's, paid, and unpaid internships. The type of companies ranges from working at startups or local companies like Gainesville Regional Utilities (GRU) to established companies like Google and Amazon. The internship positions offered in these computing domains and company types are competitive and employers make hiring

decisions through an elaborate process. This process consists of screening candidates through the Applicant tracking system (ATS) which select candidates based on keywords in a resume, employee referrals, or manually selecting candidates after interactions at career fairs and company information sessions. Companies then have one or more interviews to assess a potential candidate's technical and professional skills. A majority of companies ask CS students technical questions related to computing of which the infamous programming interview questions are most prominent [5]. In these interviews, students are asked to either write programs on whiteboards or shared-screen text editors regarding data structures, algorithms, and system design [4,27,28]. Students are evaluated on problem-solving skills, thought processes, and the ability to derive correct solutions in a limited timeframe. Some universities require students to pursue an internship before graduation while others have no such requirement.

4 FINDINGS

Our research question focused on understanding why most students in our sample (59.9% of 533 students) are not participating in internships (RQ. *What barriers do CS undergraduate students, who do not intern, encounter in securing an industry internship?*). To answer this research question, we analyzed student responses to an open-ended question in the survey, *“Why haven't you interned so far?”*. We used thematic analysis and coded student responses into 434 primary codes, 70 unique codes, and 18 categories. Four themes emerged from these categories (see Table 3 and Figure 1).

Table 3. Themes for Barriers to Securing Internships (N=302)

Themes	Count (n)	Percentage
Low self-efficacy	149	49.3%
Actions	113	37.4%
Alternate priority	102	33.8%
Application process challenges	16	5.3%

4.1 Low self-efficacy

In this theme, 49.3% of the 302 CS undergraduate students who did not intern (n=149) described that they were either not applying for internships or were not securing applied positions due to properties related to self-efficacy. These properties fell into three broad categories: self-evaluation (n=85), academic status (n=71), and lack of confidence and fear (n=19).

Eighty-five students in the self-evaluation category gauged their technical competence and stated that they did not have the necessary skills, were incompetent, lacked skills they thought were sought by the industry professionals or lacked involvement in personal projects, technical interview challenges, or activities outside of coursework. Students also evaluated their competence by assessing if they had taken appropriate coursework such as *“Data Structures and Algorithms”* or if they have the necessary competencies for a specific internship position in a CS subdiscipline. Further, students who belonged to the academic status category, reported that were not applying or securing an internship because of their age, year the students were in their

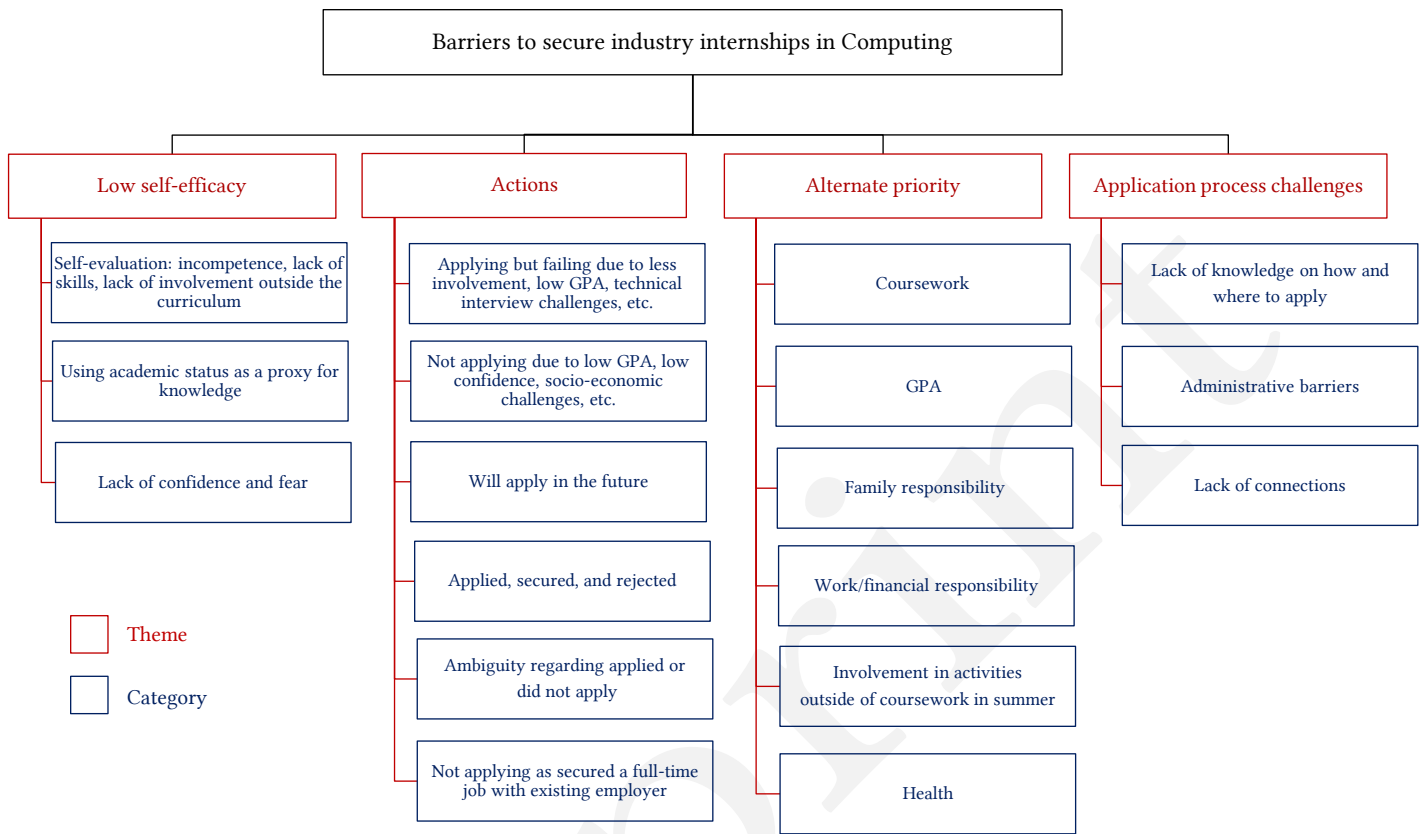


Figure 1: Thematic Analysis of Barriers to Securing Internships in Computing

degree program, student status in their program such as transfer or part-time student, or low GPA. Such students specified they were “freshman”, “sophomore”, “transfer student”, “young”, “new learner”, etc. These students used their academic status as a proxy for gauging their competence to secure an internship position. In addition, 19 students said that they lacked personal dispositional traits such as “confidence” or “motivation” to secure an internship or were “intimidated” to apply for a position. The quotes in this category were classified based on a participant’s feelings. The latter students were coded into lack of confidence and fear category. Some representative quotes from students belonging to this theme on why they did not intern include^{††}:

Self-evaluation: lack of experience and skills

“I haven’t interned yet because I’m too inexperienced to actually be competent at anything that I do, I’m still trying to transition my skills acquired in the classroom to the real world and currently I suck at that if I’m not given some form of direction or some type of hint at what I should do or how I should go about it.”

- P301, Freshman Male

“I feel like I don’t have the skills required to intern, and my resume is not great.”

- P204, Sophomore Male

“Not enough experience or intriguing personal projects; Lack of experience, work-wise and coding-wise.”

- P376, Senior Male

“I’m not good enough to qualify.”

- P341, Senior Female

Academic status: a proxy for gauging competence

“I am a freshman meaning recruiters don’t consider me a serious applicant until I’m a sophomore and have taken important classes like Data structures and computer organization.”

- P156, Freshman Male

“I am not very far in the computer science major yet and I have not gone seeking out internships.”

-P287, Sophomore Female

“I came from a community college where we learned our theoretical classes first, which is not desirable for most companies. Within a semester or two I will have the desired classes they want. I also lack technical experience via projects and club involvement.”

- P162, Junior Female

Lack of confidence and fear

“I’m not sure how to begin finding an internship and I have a lot of anxiety and feel incompetent.”

- P327, Junior Female

^{††} Participant quotes can belong to more than one theme.

"Anxiety about following through with smaller companies and a fear of rejection by putting myself out to a large number of internships."
- P241, Senior Male

When we disaggregated the demographics of the students to understand if low self-efficacy was dependent on gender and if low self-efficacy was a concern only for CS students in preliminary years of their academic degree program, we found that on average females were higher in the low self-efficacy theme compared to males. 58% of the 77 females (n=45) who did not intern belonged to this theme compared to 46% of the 223 males (n=103). Specifically for the three categories, females were higher in each category: 35% of the 77 females (n=27) in self-evaluation compared to 26% of the 223 males (n=58); 31% of the 77 females (n=24) in academic status compared to 21% of the 223 males (n=46); and 8% of the 77 females (n=6) in confidence and fear compared to 6% of the 223 males (n=13).

While the freshmen who did not intern were most prominent in our sample in the self-efficacy theme (67.7% of 130, n=88), it is a cause of concern that a large number of sophomores (32.7% of 52, n=17), juniors (37.1% of 70, n=26), and seniors (29.4% of 34, n=10) who did not intern also had low self-efficacy.

4.2 Actions

Within this theme, 37.4% of the 302 CS undergraduate students who did not intern (n=113) described their actions to secure internship positions in six broad categories: applied but failed, did not apply, will apply in future, ambiguity on intent to apply, applied-secured-and-declined, and not applying because of secured full-time employment.

Of the 113 students, 41.6% described that they applied and did not succeed (n=47). Students who applied but failed to secure a position attributed their failure to lack of involvement outside of classroom in extra-curricular activities, low confidence, low GPA, less experience when compared to peers, and challenges related to coding they faced during the technical interview process. In contrast, 27.4% of the 113 students (n=31) reported explicitly that they were not applying because of low confidence, low GPA, focus on coursework and alternate responsibilities like work, family, or other socio-economic challenges discussed in Section 4.3. Further, 15.9% of the 113 students (n=18) stated that they were working on building skills and will apply in the future and 11.5% had ambiguous responses regarding whether or not they were applying for internships (n=13). In the latter category, a student responded by stating that they *"have not had an opportunity"*. In addition, 4.4% of these 113 students who did not intern (n=5) received an offer but declined an internship position due to low offered stipend, shifting priorities like starting their own company, or stating that the offered position was not related to computing. Last, two students did not apply for internships as they had secured pathways to full-time employment through their part-time work and planned to join their part-time employer after graduating.

Equal proportions of males and females were not applying for internships in our sample. Representative quotes from students belonging to this theme on why they did not intern include:

Applied but failed

Barriers in this category: Lack of involvement outside of classroom in extra-curricular activities, low confidence, low GPA, and technical interview challenges

"Recruiters that I have talked to have said to work on side projects. Companies that I have applied online to have all rejected my application."
- P250, Sophomore Male

"The internship process is difficult. I applied and interviewed with multiple companies but I didn't do great on the technical interview side because I didn't take Data Structures course yet, although I taught myself some Data Structures it didn't help that much due to my lack of deep understanding."
-P673, Junior Male

"Because they are others out there with better experience for the internships that I am trying to apply for. I applied to over 15 internship opportunities but did not get beyond the first line in all of them."
- P320, Senior Male

"No offered yet thus far. I have only participated in one career showcase [career fair] and my current GPA is not pleasing."
- P401, Year 5-6 Female

Did not apply

Barriers in this category: coursework, low GPA, low confidence, socio-economic challenges like finance and family

"I have not actively searched for an internship yet. I also do not feel I am ready for one yet."
-P167, Freshman Female

"Haven't applied to many big companies that hire a lot of people. Also have been busy taking classes."
- P177, Junior Female

"I haven't applied, I had a job to support my living and school expenses and leaving for an internship would have been too much strain on me. I support myself, so I couldn't lean on my parents financials."
-P183, Senior Male

Will apply in future

"I had to take classes, and thus have no time to allocate for one as of now. In addition, I am trying to spend my freshman and sophomore years building experience. I plan on getting an internship after my Junior year when I have solidified my professional and technical experience."
- P344, Sophomore Female

Applied, secured, and declined

Barriers in this category: financial constraints and alternate interests

"I declined my internships because I want to work on my own startup."
- P630, Sophomore Male

"I am a non-traditional student with a family and cannot afford to take an internship when I instead need long-term employment. I wanted to focus on my school and graduate quickly so that I could

support my family. I actually interviewed for and was accepted for a Summer 2019 internship, but I could not afford to travel to Tampa and support my family with the offered compensation.”

- P600, Senior Female

4.3 Alternate priority

In this theme, 33.8% of the 302 CS undergraduate students (n=102) described they had not interned as they were focusing on coursework or improving their GPA (n=67), managing responsibilities revolving around work or family (n=26), or were involved in other activities over summer including study abroad (n=6), research (n=4), relaxation (n=2), startup (n=1), and personal project (n=1). The students who focused on coursework or improving their GPA wanted to build technical and professional competencies through curriculum, planned to graduate early, or had a hard time to manage coursework and extra-curricular activities. In addition, two students described that they did not intern because of medical conditions or health problems. Students also explained they had difficulties in managing time for multiple activities or wanted to focus on coursework during summer for graduating early. Some representative quotes in this theme included,

Focus on coursework and GPA

“I have been busy trying to keep my grades up for all of my classes, and I have found I am having difficulty with some; I am afraid that an extra workload in the form of an internship would bring my GPA to a dangerous low.”

- P243 Freshman Female

“I wanted to get further along with my courses and leave my internship for my last semester, this would allow me to hopefully transition into a job easier.”

- P364, Junior Male

Family, work, and financial responsibilities

“I haven't had the time since I have a job and classes, and I don't think I'm far enough into the major to be able to take on an internship.”

- P654, Sophomore Female

“I have a full-time job, taking CS one or two courses at a time to be able to balance. I've also been moving for my job.”

- P563 Junior Female

“Classes consume a lot of my time, my family's financial situation is also dire, and I more or less don't have the money to pay for housing elsewhere.”

- P397, Junior Male

“Due to financial issues, I have had to study and work at the same time and have not had as much time to reach out for internships.”

- P248, Senior Male

Involvement in activities over summer: study abroad, research, extracurricular activities like projects, etc.

“I am still in my first year of college and opted to take summer classes and do on Campus research my first summer to learn more before applying to jobs.”

- P221 Freshman Male

“I have not looked to obtain one yet. I have studied abroad instead.”

- P275 Sophomore Male

“I did not get a lot out of the Career Development Workshop/Career Showcase [career fair] this year and I am studying abroad in Hong Kong this summer instead.”

- P409 Sophomore Female

“I have not had the time as I've been busying myself with extracurriculars that I have used to enjoy my college experience.”

- P434 Junior Female

Health concerns

“For a few years it was lack of experience. In recent years I've felt more qualified, but I've dealt with a lot of health problems, and taking care of my health consumes a lot of free time that should be allocated to professional development.”

- P231, Senior Male

We also observed in this theme that females were more likely to be focused on coursework (29.9% of 77 females, n=23) when compared to males (19.3% of 223 males, n=43), while males were more likely to manage responsibilities revolving around work or family with coursework (9.9% of 223 males, n=22) when compared to females (5.2% of 77 females, n=4).

4.4 Application process challenges

5.3% of the 302 CS undergraduate students who did not intern (n=16) described that they had limited knowledge of how and where to apply for internship positions, lacked connections to apply for internships, or had visa restrictions that hindered them from participating in internships. Survey respondents like, P465, a male freshman who doesn't “know where to find internship opportunities” or P541, a male freshman who did not intern “mainly due to a lack of connections” fell in this theme. Other representative quotes of students belonging to this theme on why they did not intern include,

Lack of knowledge on how and where to apply

“I am having difficulties with my academics and do not know how to find one.”

- P246, Freshman Male

“I find it hard to find a company that will give me an internship in something I am interested in such as cybersecurity.”

- P591 Sophomore Male

“Haven't had relevant coursework or found employers willing to take interns with less than the usual required classes.”

- P284 Junior Male

Administrative barriers

“I have not interned so far because my status with the United States does not allow me to obtain a job.”

- P129 Freshman Female

Thus, we found that the barriers faced by students who do not intern include low self-efficacy to apply or secure an internship position, less agency to apply for internship positions, focus on alternate priority including coursework, family/work/financial responsibilities, or challenges related to the application process.

5 DISCUSSION AND CONCLUSION

Our paper contributes to the CS Education literature an understanding of the barriers that hinder CS undergraduate students' ability to secure industry internships. Four themes emerged related to these barriers: Low self-efficacy, Actions, Alternate priority, and Application process challenges. We found that a majority of students who do not intern had low self-efficacy and they evaluated themselves as incompetent for securing an internship due to lack of technical skills, relevant experiences, or where they were in the degree program. There is a possibility that the students' evaluation of themselves as lacking technical skills is erroneous and based on misconceptions given that some students stated in the survey that companies do not hire interns until junior year or companies require a high GPA from potential interns. These conceptions are not true given that our analysis from the same dataset as used in this paper has shown that 20% of the freshman and 45% of the sophomores pursue an internship [24]. Further, we have also found that there is no statistically significant difference in the GPA of students who intern and those who do not intern and students who had less than a 3.0 GPA on a 4.0 scale also secured internships at top tech companies in the United States [24], thus contradicting these students' conceptions.

Further, CS undergraduate students also felt incompetent due to their academic status, which included the time they spent in the degree program or their experience in computing. They described lower confidence as well as fear of rejection which hindered them from even applying for positions. According to the Social Cognitive Career Theory (SCCT), these students lacked the necessary agency to form performance goals [25]. This performance goal of securing an industry internship is necessary to stretch a student's perceived ability and for attaining motivation to overcome obstacles that include applying to various companies for intern positions or preparing for the interviews.

The students who did not intern also had alternate priorities including coursework or work/family responsibilities that hindered their ability to secure or apply for an internship position. SCCT suggests that during the process of career exploration and skill development, students may face financial, cultural, or systematic obstacles or have varying levels of support from influential others. These obstacles may subsume students' agency thereby hindering the formation of performance goals that stretch the individual beyond their perceived abilities [25]. In accordance with SCCT, we observed in our data that some students may not adequately harness the process of skill development, experiential learning, and career exploration due to financial constraints, administrative constraints such as visas, academic constraints such as maintaining a GPA, social constraints including family responsibilities, psychological constraints such as low self-efficacy, and recruitment-process constraints which includes technical interview challenges or involvement in projects and extra-curricular activities. These constraints suggest that in addition to the course load in CS undergraduate curriculums, the

industry expects student involvement outside the curriculum in terms of professional development and skill-building. Moreover, our students may face several other constraints outside of their academic life such as financial hardships that further exacerbate their ability for securing an internship. Leveraging financial capital to minimize these constraints by developing support programs for skill development and career exploration especially for such students might increase their competitiveness for joining the workforce or for securing an internship. Further, incorporating elements from other professional activities within the CS coursework can also reduce the burden on our students, especially for those students who do not attend informal activities such as clubs, thus increasing their ability for securing internships.

With regard to Bandura's properties for human agency: intentionality, forethought, self-reactiveness, and self-reflectiveness [3], the students who did not intern stated that they were not applying for internship positions, not preparing for securing internships as they had alternate priorities, and felt academically incompetent due to their self-evaluation or where they were in their degree program. While some students were applying and not securing internships, others were not intentional in their approaches for securing internships, lacking the necessary forethought needed to secure an internship. Some students also relied on coursework or their high GPA for securing an internship not knowing that active preparation is required outside the curriculum to secure a position. Students who are not applying for internships are losing an opportunity to improve professional and technical skills sought by the industry and for subsequently regulating their behavior to gain professional competence. Thus, such students lack agentic resources necessary to thrive through the industry recruitment process.

To conclude, students who did not intern were either applying and not securing an internship or lacked agentic resources that hindered their ability to secure internships. For the former students, we suggest the departments develop programs for improving technical competence and honing professional skills, while for the latter group, departments need to introduce programs for improving self-efficacy or for developing students' confidence. Without such support programs, SCCT suggests that regardless of a student's level of skills, talent, and interest, individuals will not have an opportunity to form strong self-efficacy and positive outcome beliefs [25]. Further, this hindrance to the students' career exploration and attainment process can lead them to doubt their competence or later join the workforce after graduation with an underprepared skillset. How will we satisfy the demand for computing graduates in such a scenario?

6 RECOMMENDATIONS

We highly recommend that departments develop specific professional development programs targeting students who have work/family responsibilities as well as find mechanisms for better dissemination of professional development opportunities given that students may not be taking advantage of these

opportunities and have misconceptions about the industry recruitment process. In addition, we suggest instructors and educators incorporate authentic skills required from the industry recruitment process within the curriculum so that all students can balance coursework with professional development and gain competencies in these skills. An example could be to use GitHub [47] for submitting projects so that students can show their portfolio to recruiters or using online code judges in Data Structures and Algorithms course where students can practice the implementation of various data structures for technical interviews. This is necessary as CS students who have responsibilities outside of the classroom such as work have limited opportunities for participation in extra-curricular at the university. We also suggest the instructors and departments to encourage students to pursue internships and disseminate the importance of pursuing internships. Finally, we encourage departments to assist student organizations and other professional development avenues which provide students an opportunity for career exploration and developing technical or professional skills.

7 LIMITATIONS

The findings presented in this paper represent a snapshot of the internship experiences taken from a sample of CS students at two US-based public universities. Our sample at Site B was relatively smaller than Site A and thus there is a higher likelihood of non-response bias at Site B. We collaborated with one course instructor for extra-credit at Site B. In the future, we would like to collaborate with more instructors for offering extra-credit, given the response rates were higher for extra-credit than for random gift cards. We also had a lower sample of certain groups such as Females or African Americans, but such samples were proportional to the respective proportions at the individual universities.

Further, the number of students at Site B (57%) who interned were higher than those at Site A (38%). The number of students at Site B who interned may not be representative of the population of students enrolled at Site B given the small sample and should be interpreted with caution. Larger sample size is required to understand the percentage of students who intern at Site B. However, the internships pursued by the students at both universities were actual real-world industry internships rather than interventions designed by academic-industry collaborations. Thus, student experiences in the real world strengthen external validity and our findings should generalize to CS undergraduate students who apply for internships in the industry in the United States.

Our findings may not generalize to experiences of CS students in other countries or other settings given the differences in the cultural context. In addition, our findings may not generalize to other schools that make internships mandatory for students before graduation. We provide a description of the two research sites and leave it up to the readers to make appropriate inferences of our findings at similar types of institutions. Finally, we attempt to address the validity of our qualitative inquiry through the transparency of our research

process, using participants' quotes, as well as recognizing the researchers' positionality.

8 FUTURE WORK

In the future, we would present a deeper analysis of the qualitative data by including the interview data. Also, we would analyze our data using Generalized Linear Modeling (Logistic Regression), to understand which of the factors contribute more to help our students to secure an industry internship. Finally, we have also collected resumes in the Documents section of our survey and analysis of the resumes might help us in identifying how our students are presenting themselves to the recruiters/industry professionals for securing an internship position. This latter document analysis might help us in gaining insights about the extent to which students lack agentic resources for the minimal requirements to secure an internship.

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