Exploring the Participation of CS Undergraduate Students in Industry Internships

Amanpreet Kapoor
Computer & Info. Science & Engineering
University of Florida, Gainesville, FL, USA 32611
kapooramanpreet@ufl.edu

Christina Gardner-McCune
Computer & Info. Science & Engineering
University of Florida, Gainesville, FL, USA 32611
gmccune@ufl.edu

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

SIGCSE '20, March 11–14, 2020, Portland, OR, USA

ACM 978-1-4503-6793-6/20/03...$15.00
https://doi.org/10.1145/3328778.3366844

ACM Reference format:

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

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 $p<=0.05$, $\alpha=5\%$ 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:

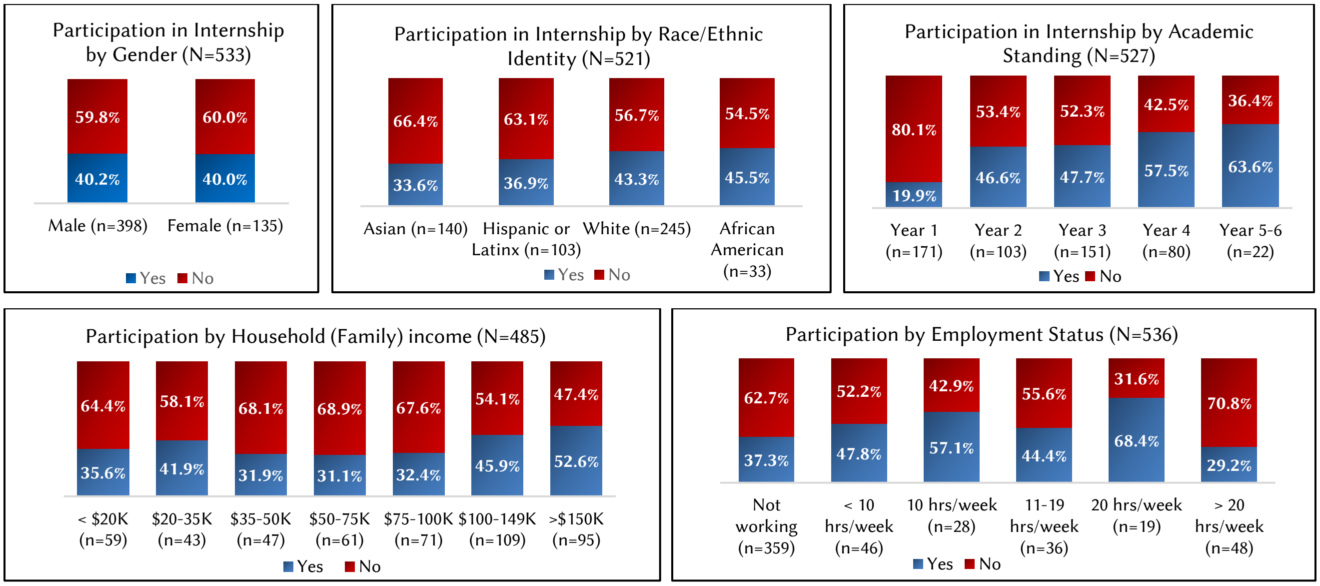
1. Chi-square test of independence (both nominal variables): to determine if there is an association between our nominal variable, Participation in internships, and another nominal variable. The null hypothesis for the test assumes there is no association between the two variables. For example, to understand 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 (α=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

	Statistical Significance			Effect Size
Demographic*	**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.

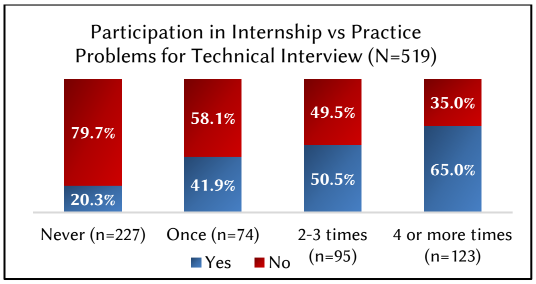
"Making sure my grades are impressive and taking as much away (e.g. skills and knowledge) from my classes as possible."

- 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, χ^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, η^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, η^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.

ACKNOWLEDGEMENTS

The authors would like to thank Michael Hewner, Jennifer Whitlow, Joshua Gross, Victoria Hong, Jeremiah Blanchard, Joshua Fox, Philippa Brown, and Peter Dobbins for supporting the data collection process, and Kimberly Ying, Fernando Rodríguez, Mehmet Celepkolu, and Joseph Wiggins for their valuable feedback on the paper. We would also like to express our gratitude to the anonymous reviewers for their valuable comments during the review process. This work is supported in part by the SIGCSE Special Project Grant. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and do not necessarily represent the official views, opinions, or policy of the SIGCSE Board.

REFERENCES

[1] Bandura, A. 1989. Human agency in social cognitive theory. *American Psychologist*. 44, 9 (1989), 1175–1184. DOI:https://doi.org/10.1037/0003-066X.44.9.1175.

[2] Bandura, A. 2006. Toward a Psychology of Human Agency. *Perspectives on Psychological Science*. 1, 2 (Jun. 2006), 164–180. DOI:https://doi.org/10.1111/j.1745-6916.2006.00011.x.

[3] Brechner, E. 2003. Things they would not teach me of in college. *Companion of the 18th annual ACM SIGPLAN conference on Object-oriented programming, systems, languages, and applications - OOPSLA '03* (New York, New York, USA, 2003), 134.

[4] Burns, C. 2017. *Systematic analysis of industry engagement activities on student learning in the undergraduate technology program*. Iowa State University, Digital Repository.

[5] Carmichael, G., Jordan, C., Ross, A. and Evans Adnani, A. 2018. Curriculum-Aligned Work-Integrated Learning: A New Kind of Industry-Academic Degree Partnership. *Proceedings of the 49th ACM Technical Symposium on Computer Science Education* (New York, NY, USA, 2018), 586–591.

[6] Cohen, J. 2013. *Statistical Power Analysis for the Behavioral Sciences*. Routledge.

[7] Computer Science is for Everyone! | whitehouse.gov: *https://obamawhitehouse.archives.gov/blog/2013/12/11/computer-science-everyone*. Accessed: 2018-01-21.

[8] Creswell, J.W. and Creswell, J.D. 2017. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

[9] Data Buddies - Center for Evaluating the Research Pipeline: *https://cra.org/cerp/data-buddies/*. Accessed: 2019-08-31.

[10] Davis, J. and Rebelsky, S.A. 2019. Developing Soft and Technical Skills Through Multi-Semester, Remotely Mentored, Community-Service Projects. *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (New York, NY, USA, 2019), 29–35.

[11] Dean, C., Lynch, T.D. and Ramnath, R. 2011. Student perspectives on learning through developing software for the real world. *2011 Frontiers in Education Conference (FIE)* (Oct. 2011).

[12] Exter, M. 2014. Comparing educational experiences and on-the-job needs of educational software designers. *Proceedings of the 45th ACM technical symposium on Computer science education - SIGCSE '14* (New York, New York, USA, 2014), 355–360.

[13] Freeman Hennessy, K., Parham-Mocello, J. and Walker, H. 2019. Co-Curricular Activities in Computer Science Departments. *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (New York, NY, USA, 2019), 1248.

[14] Fryling, M., Egan, M., Flatland, R.Y., Vandenberg, S. and Small, S. 2018. Catch 'em Early. *Proceedings of the 49th ACM Technical Symposium on Computer Science Education - SIGCSE '18* (New York, New York, USA, 2018), 658–663.

[15] Gardner, J. and Veer, G. Van der 1998. *The Senior Year Experience. Facilitating Integration, Reflection, Closure, and Transition*. Jossey-Bass Inc., Publishers.

[16] GeeksforGeeks | A computer science portal for geeks: *https://www.geeksforgeeks.org/*. Accessed: 2019-08-31.

[17] HackerRank: *https://www.hackerrank.com/*. Accessed: 2019-08-31.

[18] Hahs-Vaughn, D. and Lomax, R. 2013. *An introduction to statistical concepts*. Routledge.

[19] Internships Enhance Student Research and Educational Experiences: *https://cra.org/crn/2008/11/internships_enhance_student_research_and_educational_experiences/*. Accessed: 2019-08-31.

[20] Kapoor, A. 2019. Deconstructing Successful and Unsuccessful Computer Science Undergraduate Interns. *SIGCSE 2019 - Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (2019), 1297–1297.

[21] Kapoor, A. and Gardner-McCune, C. 2020. Barriers to Securing Industry Internships in Computing. *ACE 2020 - Proceedings of 22nd Australasian Computing Education Conference* (2020).

[22] Kapoor, A. and Gardner-McCune, C. 2019. Understanding CS undergraduate students' professional development through the lens of internship experiences. *SIGCSE 2019 - Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (Feb. 2019), 852–858.

[23] Kapoor, A. and Gardner-McCune, C. 2018. Understanding professional identities and goals of computer science undergraduate students. *SIGCSE 2018 - Proceedings of the 49th ACM Technical Symposium on Computer Science Education* (Feb. 2018), 191–196.

[24] Lawrence-Fowler, W.A., Grabowski, L.M. and Reilly, C.F. 2015. Bridging the divide: Strategies for college to career readiness in computer science. *2015 IEEE Frontiers in Education Conference (FIE)* (Oct. 2015), 1–8.

[25] LeetCode - The World's Leading Online Programming Learning Platform: *https://leetcode.com/*. Accessed: 2019-08-31.

[26] McCartney, R. and Sanders, K. 2015. School/Work: Development of Computing Students' Professional Identity at University. *Proceedings of the eleventh annual International Conference on International Computing Education Research - ICER '15* (New York, New York, USA, 2015), 151–159.

[27] McDowell, G.L. 2019. *Cracking the coding interview: 189 programming questions and solutions*. CareerCup.

[28] National Association of Colleges and Employers 2014. *The Class of 2014 Student Survey Report*.

[29] Olarte, J.J., Dominguez, C., Jaime, A. and Garcia-Izquierdo, F.J. 2019. Impact of Part-Time CS Engineering Internships on Workload. *Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education* (New York, NY, USA, 2019), 318.

[30] Parker, R. 2018. Developing Software Engineers: A study of professionalization in a CS Senior Capstone. *Proceedings of the 49th ACM Technical Symposium on Computer Science Education - SIGCSE '18* (New York, New York, USA, 2018), 276–276.

[31] Radermacher, A. and Walia, G. 2013. Gaps between industry expectations and the abilities of graduates. *Proceeding of the 44th ACM technical symposium on Computer science education - SIGCSE '13* (New York, New York, USA, 2013), 525.

[32] Rules of thumb on magnitudes of effect sizes: 2009. *http://imaging.mrc-cbu.cam.ac.uk/statswiki/FAQ/effectSize*. Accessed: 2019-08-31.

[33] Schambach, Thomas P. Dirks, J. 2002. Student Perceptions of Internship Experiences. *International Academy for Information Management* (2002).

[34] Strauss, A. and Corbin, J. 2008. *Basics of Qualitative Research*. SAGE Publications, Inc.

[35] Student Experience of the Major (SEM): *https://www.ncwit.org/sites/default/files/resources/sem_survey_in_a_box_0.pdf*. Accessed: 2018-01-21.

[36] Tan, J. and Phillips, J. 2005. Incorporating Service Learning into Computer Science Courses. *J. Comput. Sci. Coll.* 20, 4 (Apr. 2005), 57–62.

[37] The Labor Market for Recent College Graduates: *https://www.newyorkfed.org/research/college-labor-market/college-labor-market_compare-majors.html*. Accessed: 2018-08-31.

[38] The Positive Implications of Internships on Early Career Outcomes: *http://www.naceweb.org/job-market/internships/the-positive-implications-of-internships-on-early-career-outcomes/*. Accessed: 2018-08-31.

[39] Thiry, H., Laursen, S.L. and Hunter, A.-B. 2011. What Experiences Help Students Become Scientists? A Comparative Study of Research and other Sources of Personal and Professional Gains for STEM Undergraduates. *The Journal of Higher Education*. 82, 4 (Jul. 2011), 357–388. DOI:https://doi.org/10.1080/00221546.2011.11777209.

[40] Tomer, G. and Mishra, S.K. 2016. Professional identity construction among software engineering students. *Information Technology & People*. 29, 1 (Mar. 2016), 146–172. DOI:https://doi.org/10.1108/ITP-10-2013-0181.

[41] Zehr, S.M. 2016. *Student Internship Experiences And Learning Opportunities: A Mixed Methods Study*.