

Exploring the Participation of CS Undergraduate Students in Industry Internships



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Industry Internships

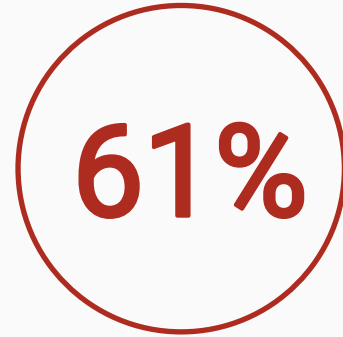
- Gain authentic experiences^{1,2}
- Explore computing pathways¹
- Build technical skills^{1,2}
- Develop professional skills^{1,2}
- Secure future employment³

Source

1. Amanpreet Kapoor, Christina Gardner-McCune. 2019. Understanding CS Undergraduate Students' Professional Development through the Lens of Internship Experiences. SIGCSE '19
2. Joann J. Ordille. Internships Enhance Student Research and Educational Experiences. https://cra.org/crn/2008/11/internships_enhance_student_research_and_educational_experiences/
3. National Association of Colleges and Employers. 2014. The Class of 2014 Student Survey Report. Bethlehem. Retrieved August 31, 2018 from www.naceweb.org

Industry Internships

- Gain authentic experiences^{1,2}
- Explore computing pathways¹
- Build technical skills^{1,2}
- Develop professional skills^{1,2}
- Secure future employment³



Participation in Internships before
Graduation across all majors in the US³

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3. National Association of Colleges and Employers. 2014. The Class of 2014 Student Survey Report. Bethlehem. Retrieved August 31, 2018 from www.naceweb.org

Typical Hiring Process for CS Internships in USA



- Applying at Career Fairs
- Online for Paid/Unpaid/Co-op Internships in Computing Disciplines

- Resume by Application Tracking System,
- Referrals, or
- Recruiters or a
- Technical/Aptitude Test

- 0-4 remote or in-person Technical
Requires: Coding + Data Structures + System Design
- Behavioral interviews.

Expectations: Technical Skills + Professional Skills + Technical Interview Preparation & Practices + Working outside the curriculum

Theoretical Framework: Social Cognitive Theory (1989)

Bandura's Social Cognitive Theory elaborates on

- (1) Human agency : actual ability to deal with a complex task
- (2) Self-efficacy : the belief that one has about their capacity for specific achievements, given domain-specific obstacles

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.

Source

Albert Bandura (1989). Human agency in social cognitive theory

Author's Position



Agency

identified through proxies

- behavior of applying for internship positions
- preparing for job interviews
- building technical and professional skills



Cognitive Development

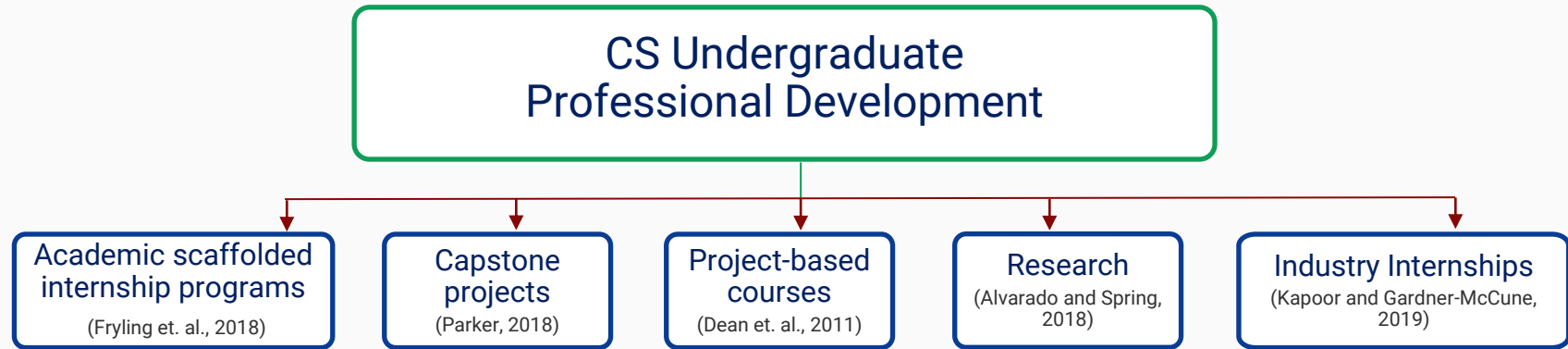


Securing an internship (a desired future outcome)

Source

Albert Bandura (1989). Human agency in social cognitive theory

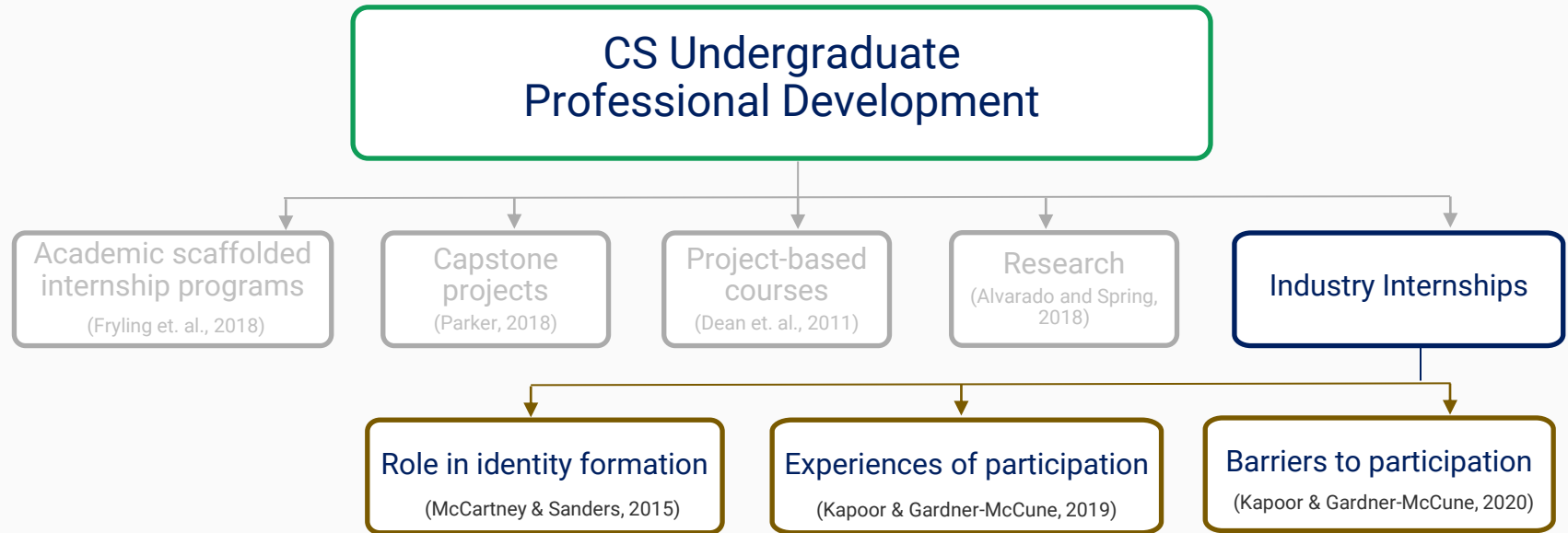
Existing Research in CS Undergraduate Professional Development



Source

- Alvarado and Spring (2018). Successfully Engaging Early Undergraduates in CS Research. SIGCSE '18
- Kapoor and Gardner-McCune (2019). Understanding CS Undergraduate Students' Professional Development through the Lens of Internship Experiences. SIGCSE '19
- Dean, Lynch, and Ramnath (2011). Student perspectives on learning through developing software for the real world. FIE '11
- Fryling, Egan, Flatland, Vandenberg, and Small (2018). Catch 'em Early: Internship and Assistantship CS Mentoring Programs for Underclassmen. SIGCSE '18
- Parker (2018). Developing Software Engineers: A study of professionalization in a CS Senior Capstone. SIGCSE '18

Existing Research in CS Undergraduate Professional Development



Source

McCartney and Sanders (2015). School/Work: Development of Computing Students' Professional Identity at University. ICER '15
Kapoor and Gardner-McCune (2019). Understanding CS Undergraduate Students' Professional Development through the Lens of Internship Experiences. SIGCSE '19
Kapoor and Gardner-McCune (2020). Barriers to Securing Industry Internships in Computing. ACE '20

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?

Study Design & Institutions

- **Cross-sectional** mixed-methods (**survey** and interviews) study at three institutions in Spring 2019 focused on four-year CS programs
 - University of Florida (public)
 - Georgia Institute of Technology (public)
 - Rose-Hulman Institute of Technology (private)
- At the three institutions
 - Admission is competitive
 - Students can choose a major when they start college but can change at anytime
 - Internship is not required for graduation

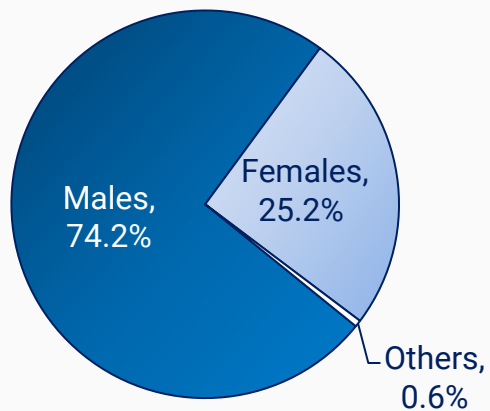


Participants included in Data Analysis

- 536 students completed more than 80% of the survey (Average Completion Rate: 99.76%)
 - University of Florida (n=485, Response Rate: 44.0%)
 - Georgia Institute of Technology (n=44, Response Rate: 18.4%)
 - Rose-Hulman Institute of Technology (n=7)
- Average Age: 21.1 years (SD: 3.75, Min = 17, Max = 52)
- Recruitment through
 - Extra credit in Computing Courses (n=525)
 - Random Gift Card (n=11)

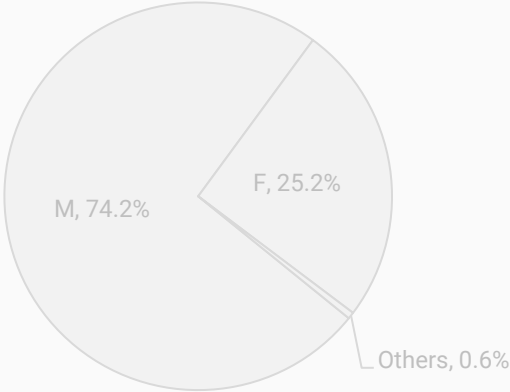
Participant Demographics

Gender Identity, N=536

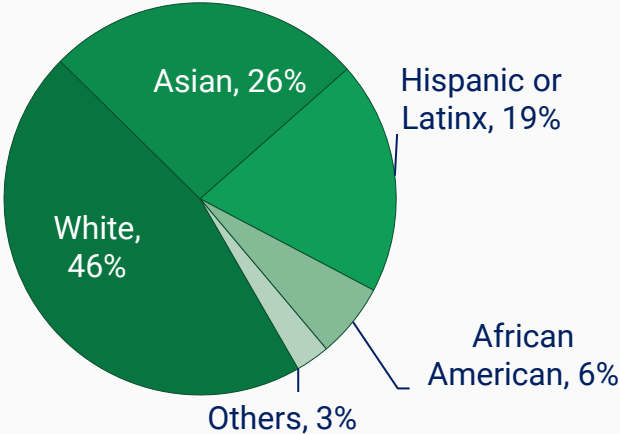


Participant Demographics

Gender Identity, N=536

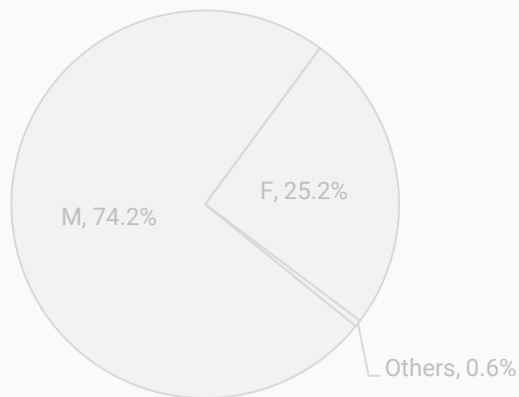


Racial/Ethnic Identity, N=536

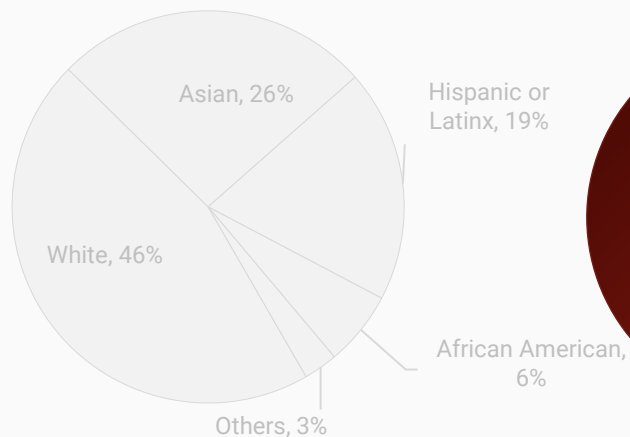


Participant Demographics

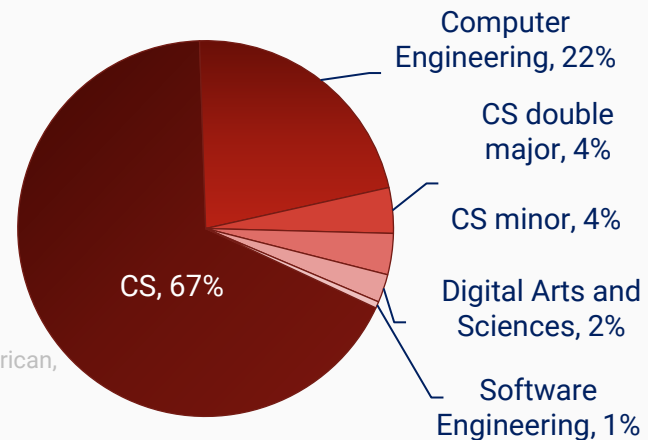
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Racial/Ethnic Identity, N=536

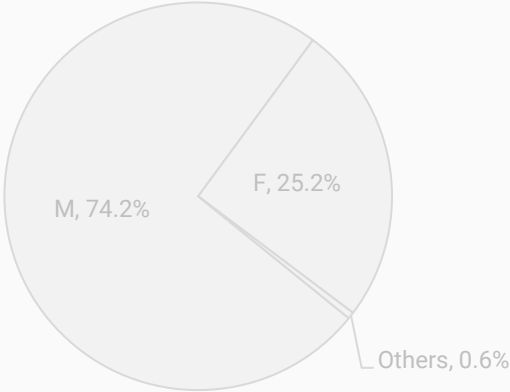


Major, N=536

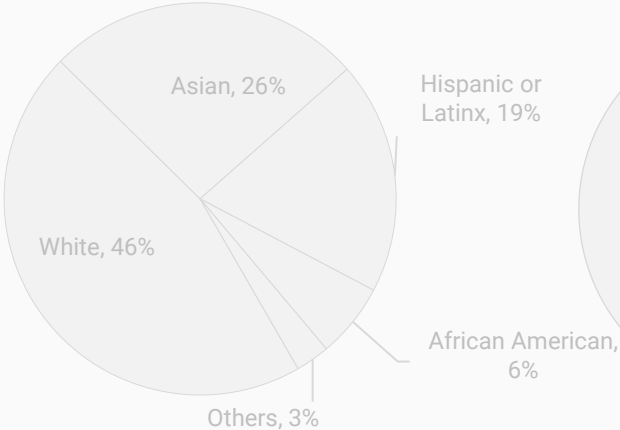


Participant Demographics

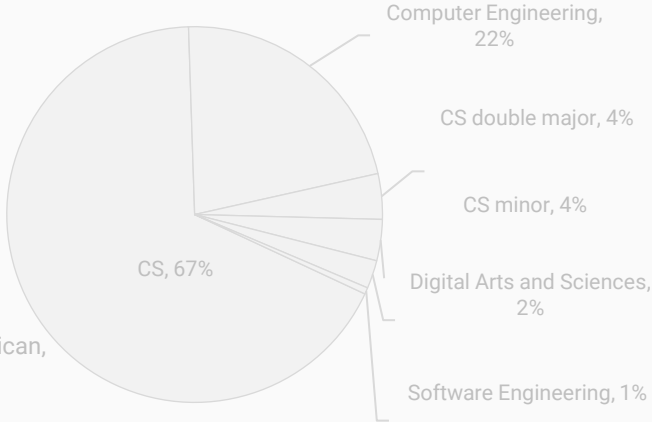
Gender Identity, N=536



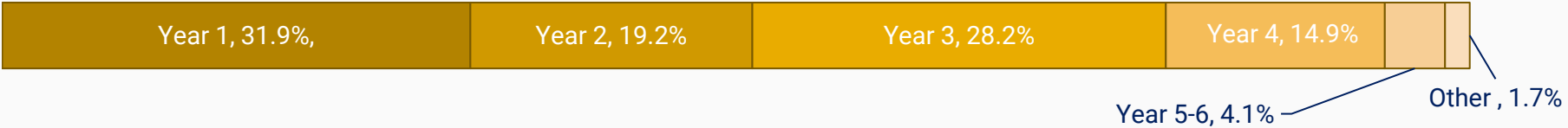
Racial/Ethnic Identity, N=536



Major, N=536



Academic Year, N=536



Qualtrics Survey (Average Completion Time: 37.3 minutes)

- 11 Sections including
 - Consent
 - Demographics
 - Professional Identity
 - Industry
- Multiple-choice questions, short-responses & open-ended responses
- Questions based on:
 - NCWIT Student Experience of the Major Survey
 - CRA Data Buddies Survey
 - Results from our Qualitative analysis of pilot study

Analysis Focus

- Eight quantitative factors from the Demographics & Professional Development sections
- One open-ended question from Industry section

- Descriptive and Inferential Statistics on two groups:
 - Students who interned or were interning the summer following the study
 - Students who did not secure an internship

- Statistical Tests and Practical Significance
 - Chi-square test of independence (both nominal variables), Effect Size: Cramer's V
 - Mann-Whitney U two-tailed test (one nominal, one ordinal/interval), Effect Size: η^2

- $p < 0.05$, $\alpha = 5\%$ to reject our corresponding null hypothesis

Data Analysis: Qualitative

How did you prepare or how are you preparing to get an internship?

Raw Data (486)	By joining clubs and student organizations to network with companies and upperclassmen. I'm preparing to get an internship by networking with girls in my sorority and by joining engineering clubs where I can learn how to develop a strong resume . –P135			I'm preparing by talking to upperclassmen who gain an internship and by learning new things on my own. – P150		I am working my way through classes and browsing internship opportunities online, as well as reaching out to family/friends for connections . –P195
Primary Code (72)	working on resume	networking	join clubs	receive mentoring	connection	
Categories (7)	Application Contents	Application Strategies				
Themes (4)	Engagement in the Application Process					

FINDINGS



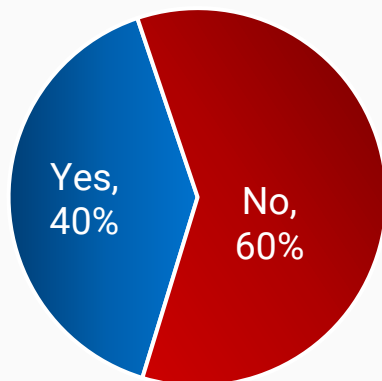
PARTICIPATION

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



RQ.1 Participation in Industry Internships

Participation in Internship (N=536)

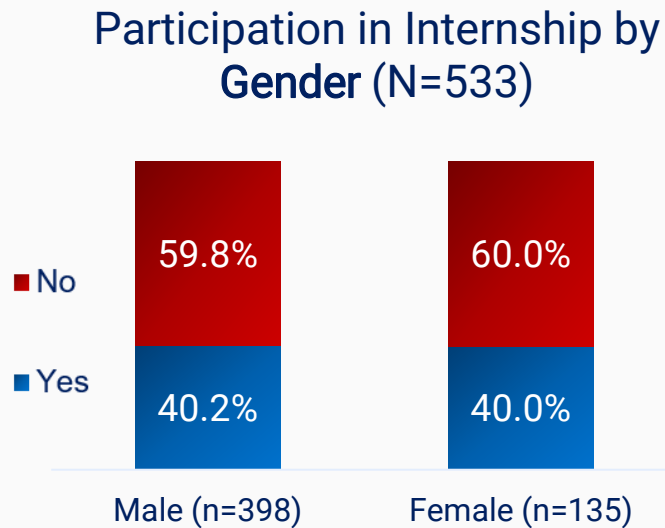


- 37.7% at University of Florida (n=183)
- 56.8% at Georgia Institute of Technology (n=25)
- 100% at Rose-Hulman Institute of Technology (n=7)

Internships

- during 4+ years at universities
- various CS subdisciplines
- diverse types of companies

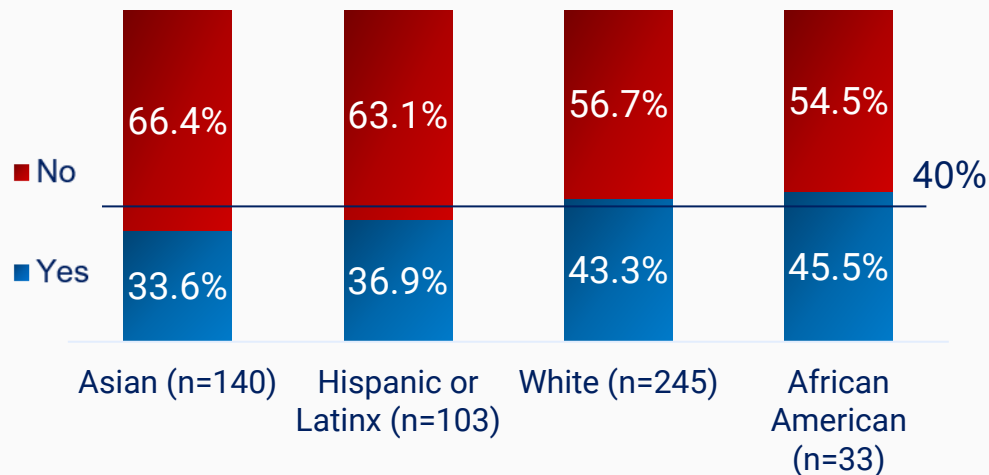
RQ.1 Participation in Industry Internships: Gender Identity



χ^2	df	p-value
0.00	1	1.000

RQ.1 Participation in Industry Internships: Race/Ethnic Identity

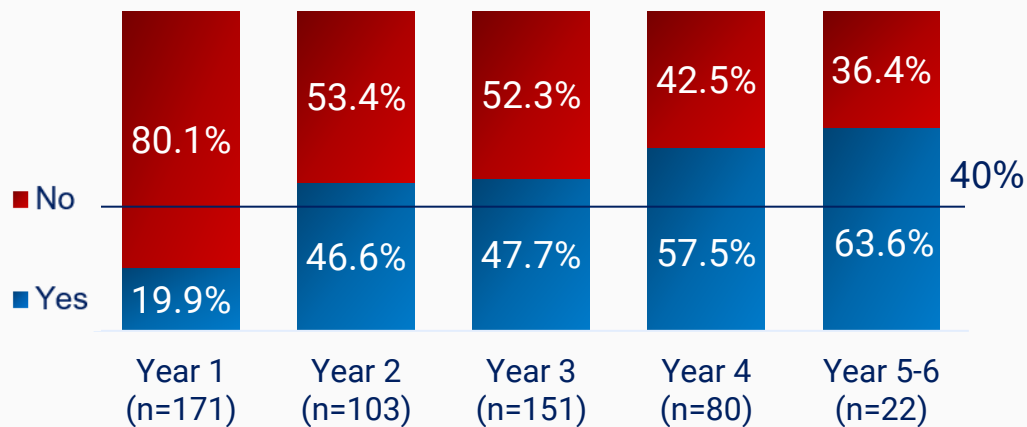
Participation in Internship by Race/Ethnic Identity (N=521)



χ^2	df	p-value
4.29	3	0.230

RQ.1 Participation in Industry Internships: Academic Standing

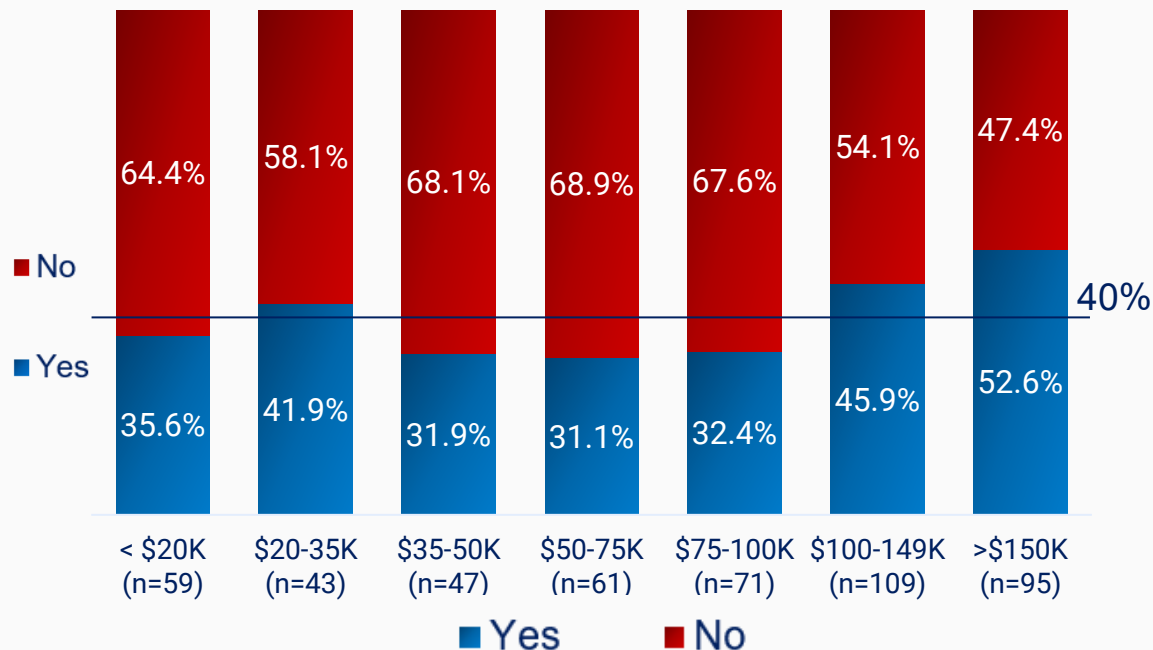
Participation in Internship by Academic Standing (N=527)



z	p-value	η^2
-6.63	0.000	0.083

RQ.1 Participation in Industry Internships: Household Income

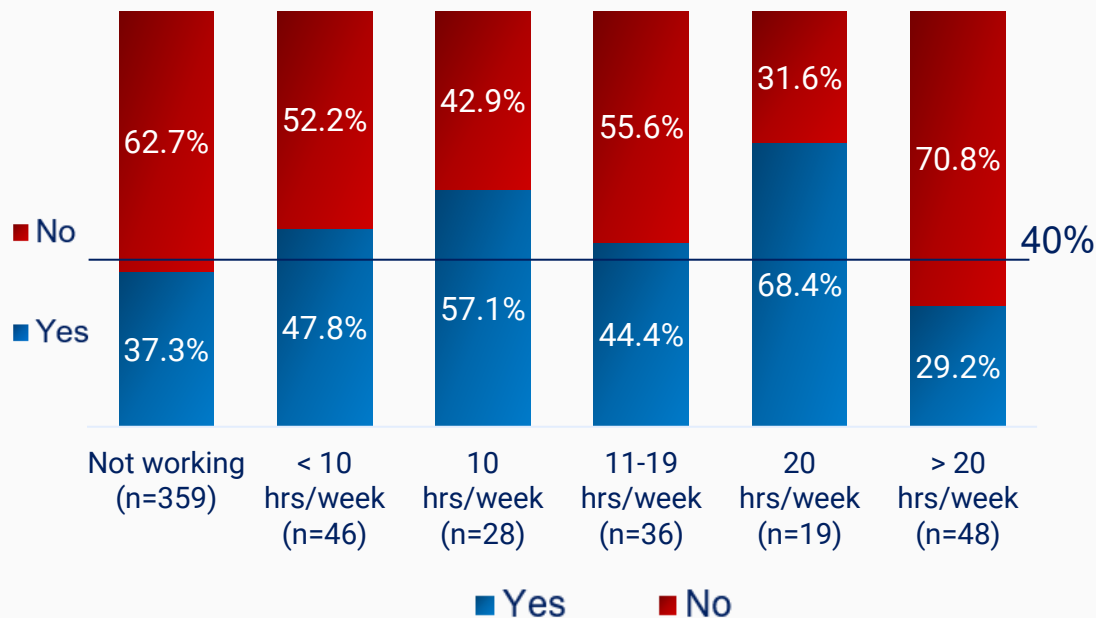
Participation by Household (Family) income (N=485)



z	p-value	η^2
-2.76	0.006	0.016

RQ.1 Participation in Industry Internships: Employment Status

Participation by Employment Status
(N=536)



z	p-value	η^2
-1.46	0.140	0.004

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

- **40%** of CS undergraduate students **intern before graduation**
- **59%** of the **graduating** CS undergraduate **students** (Year 4-5-6) **intern**
- CS students with **higher socioeconomic status** are **more likely to intern**
- **No statistically significant differences** across **gender, racial/ethnic identity, and part-time employment**

PREPARATION

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



RQ.2 Preparation Process of Interns and Students who do not Intern

893 Codes (72 Unique Codes) \Rightarrow 7 Categories \Rightarrow 4 Themes

How did you prepare or how are you preparing to get an internship?	N=486
Engagement in the Application Process	45.7%
Skill Building	44.9%
Explicit Interview Preparation	27.4%
Status quo: relying on coursework or no preparation	23%

RQ.2 Preparation Process of Interns and Students who do not Intern

45.70%

44.90%

27.40%

23%

Engagement in the Application Process (n=222)

- **Application Materials:** resumes, cover letters, job applications
- **Application Avenues:** online, career fairs, referrals
- **Strategies:** applying early, networking, using connections, receiving mentoring from successful peers and career centers, using LinkedIn, attend clubs, etc.

“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

RQ.2 Preparation Process of Interns and Students who do not Intern

45.70%

44.90%

27.40%

23%

Skill Building (n=218)

- **Skills:** technical (e.g. web frameworks), professional (e.g. communication), social and interviewing skills to gain competency, explore a discipline, & show employers.
- **Avenues to develop skills:** personal projects, clubs, conferences, game jams, hackathons, team projects, study abroad programs, ethical hacking, boot camps, certifications, research labs, online courses, & coursework

“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

RQ.2 Preparation Process of Interns and Students who do not Intern

45.70%

44.90%

27.40%

23%

Explicit Interview Preparation (n=133)

- Practicing **technical interview programming problems** on websites like LeetCode, GeeksforGeeks, and HackerRank
- Developing **technical interviewing skills**
- Studying **data structures and algorithms** through coursework and books like Cracking the Coding Interview
- Resources recommended by friends, recruiters and 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

RQ.2 Preparation Process of Interns and Students who do not Intern

45.70%

44.90%

27.40%

23%

Status quo: relying on coursework or no preparation (n=112)

- Relying on coursework to prepare for securing internships
- Not preparing: Lack of time to manage with coursework and lack of interest
- Secure a good GPA which will yield a future internship

“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

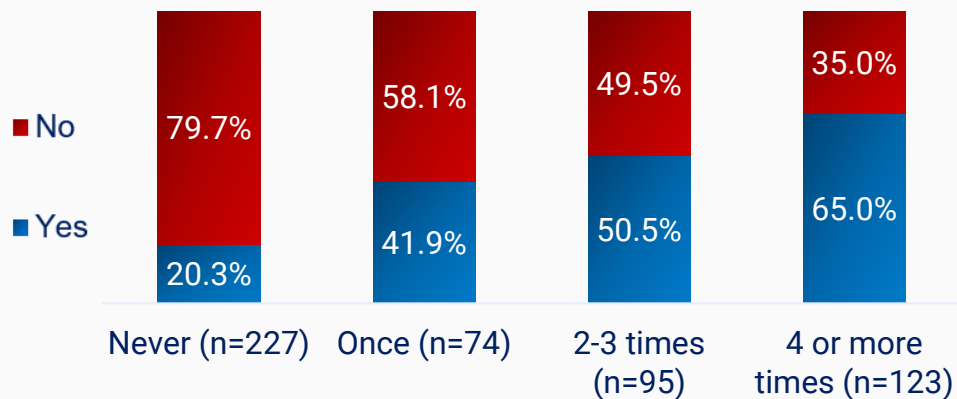
RQ.2 Preparation Process of Interns and Students who do not Intern

How did you prepare or how are you preparing to get an internship?	Internship (N=486)		χ^2 (1, N=486) p-value
	Yes (n=190)	No (n=296)	
Engagement in the Application Process	51.6%	41.9%	0.036
Skill Building	42.6%	46.3%	0.429
Explicit Interview Preparation	36.8%	21.3%	<0.001
Status quo: relying on coursework or no preparation	14.2%	28.7%	<0.001

RQ.2 Preparation Process of Interns and Students who do not Intern

Engagement and Explicit Interview Preparation

Participation in Internship vs Practice Problems for Technical Interview (N=519)



z	p-value	η^2
-8.75	<0.001	0.14

Median Weekly Hours on Career Preparation

Intern_yes = 2-3 hours

Intern_no = 1 hour

z	p-value	η^2
-4.4	<0.001	0.04

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

- **Interns** were more likely to be **engaged in the application process** when compared to students who do not intern
- **Interns** were more likely to **explicitly prepare for interviews** when compared to students who do not intern
- **Students who did not intern** were more likely to **rely on coursework/GPA** for securing internships

- **Industry expects** students to **participate in extra-curricular activities** such as hackathons and personal projects, and **pass technical interviews** before recruitment
- Students might have **misconceptions about the recruitment process** such as reliance on GPA or **lack of knowledge** about the application process¹

Source

1. Amanpreet Kapoor, Christina Gardner-McCune. 2020. Barriers to Securing Industry Internships in Computing. ACE '20.

Recommendations

- Departments should **support specific professional development programs** targeting economically burdened students or for **building students' confidence and competence**
- Departments must disseminate the **importance of pursuing internships**
- Instructors must **incorporate authentic skills** required from the industry recruitment process within the curriculum so that all students can balance coursework with professional development

Acknowledgements



Data Collection

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Questions?



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