COMPUTING UNDERGRADUATE STUDENTS’ PARTICIPATION IN INTERNSHIPS: EXPERIENCES, PREPARATION, AND BARRIERS

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2025

To our beautiful planet and all who give selflessly, advancing human civilization beyond a transactional economy!

ACKNOWLEDGMENTS

I would like to thank my supervisor, Dr. Christina Gardner-McCune, for bringing me into the Human Centered Computing (HCC) Ph.D. program, supporting and guiding me, teaching me how to pursue rigorous research, and introducing me to CS education research communities. She has been incredibly kind, humble, and patient with me, and I owe who I am today to her. I would also like to thank my committee members, Dr. Kristy Boyer, Dr. Sharon Chu, and Dr. Denise Simmons, for showing me the importance of working hard, maintaining research standards, and thinking critically. I appreciate that you all were able to oversee my work and offer insightful feedback.

Next, I want to express my gratitude to six individuals whose guidance significantly influenced my approach to academic research and professional career. These include: (1) Ashish Aggarwal, who gave the first and most consequential advice on how to write research papers and taught me a lot about empathy and philanthropy, (2) Dr. Philip Guo, whose inspiring articles and research helped me navigate academia when I had no idea how the entire system worked, (3) Dr. Jean Wang, whose advice on embracing overcommitment as a way to discover your true passions in times of uncertainty, profoundly changed my life, (4) Dr. Mark Sheplak, whose advice on how to be successful in academic research - 'Do good research, everything else follows' – shaped and will continue to shape my career, (5) Dr. Jeremiah Blanchard, who recognized my potential as an educator and encouraged me to apply for my current teaching position - his passion and dedication to rigorous teaching have continually inspired me to enhance my courses and serve our students, and (6) David Rubenstein whose lessons on leadership had and will have a profound impact on how I mentor my students.

I would also like to thank the professors who taught me how to do research in education and HCC, – Drs. Corinne Huggins-Manley, Erica McCray, Lisa Anthony, Eakta Jain, and Pasha Antonenko. Additionally, I am grateful to all the mentors and scholars who I got a chance to work closely with: Drs. Paul Denny, Arnab Ray, Brett Becker, Mats Daniels, Arnold Pears, Geoffrey Herman, Lecia Barker, Anne-Kathrin Peters, Mihaela Sabin, Natalie Kiesler, John Impagliazzo, Leo Porter, Stephen MacNeil, and Albert Ritzhaupt. Next, I would like to thank my undergraduate mentees who collaborated with me on research, and I learned a lot working with them: Sajani, Megan, Charlie, Brooke, Beatrice, Angela, Leon, Joseph, Dustin, Marc, Prayuj, Andrew, Hamish, and others.

I sincerely appreciate the instructors who helped in the data collection process for several of my studies: Drs. Cheryl Resch, Michael Hewner, Jennifer Whitlow, Joshua Gross, Victoria Hong, Joshua Fox, Lisha Zhou, Pete Dobbins, Alexandre Gomes de Siqueira, Santhia Thomas, Neha Rani, William Anderson, and everyone else who helped. Additionally, I want to give a shout-out to Ms. Adrienne Cook for her incredible support as an academic advisor in the HCC program and Prof. Hans van Oostrom for supporting me throughout the program.

Thanks to all the members of the Engaging Learning Lab and the Learn Dialogue Group - Yerika, Cheryl, Jeremiah, Ashish, David, Patriel, Joey, Mehmet, Kim, Fernando, Joseph, Xiaolong, and Lydia - with whom I formed lifelong friendships. Your support, especially during moments when I was stuck and when we shared joys and struggles, was invaluable. Additionally, I am deeply grateful to Divya Katikaneni for her unwavering generosity, friendship, and for being an inspiring example of balancing responsibilities pertaining to work and beyond, and to Dr. Ekaterina Muravevskaia for being an amazing friend and mentor, and for all the wonderful discussions we had on how to approach life and research. I also extend my heartfelt thanks to many other friends and colleagues who supported me throughout my degree, including Hardik, Hridya, Dr. Amar Shah, Bhoomik, Kartik, Akshara, Akshay, Tima, Darryl, Scott, Sabyasachi, Lisha, Kwansun, and Laura. In addition, I want to express my deepest gratitude to Harika for her unwavering support, patience, feedback, and encouragement throughout the last phase of my dissertation. Her wisdom, pragmatism, insightful questions, and ability to bring clarity to even the most overwhelming moments were invaluable.

Lastly, I am deeply grateful to my family members - my mother, sisters, brothers-in-law and nephews - for their unconditional love, support, and patience throughout my degree program. My mother worked really hard and sacrificed a lot to raise us - she is the best mom and dad on this planet – I don’t think I would have completed this dissertation without her push. I often struggled to explain to her when I would finally graduate, but it looks like I’m a tad close to the finish line!

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COMPUTING UNDERGRADUATE STUDENTS' PARTICIPATION IN INTERNSHIPS:
EXPERIENCES, PREPARATION, AND BARRIERS

By

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May 2025

Chair: Christina Gardner-McCune
Major: Human Centered Computing

Internships provide students with an opportunity to gain authentic disciplinary experiences, understand professional expectations, evaluate self-interests, and secure future employment. However, little is known about students' participation in internships within the computing discipline and the role that internships play in students' professional development. My dissertation aims to fill this gap by systematically assessing computing undergraduate students' participation in internships using the lens of Bandura's Social Cognitive Theory, Lent et al.'s Social Cognitive Career Theory, and James Marcia's theory of identity development.

I will present four studies that highlight (1) the importance of internships in computing through the lens of student experiences, (2) an empirical evaluation of students' participation in internships examining who participates, who does not, and how participation is influenced by student preparation processes and situational barriers, using a quantitative model and rich qualitative personas, (3) a pedagogical intervention, *Hire Thy Gator Technical Interview Exercises*, that we can include in our curriculum to prepare students for securing internships, and (4) a retrospective evaluation of this pedagogical intervention. Data used in these studies were collected

using surveys and interviews from over 1400 undergraduate computing students enrolled in three universities in the United States.

Our findings suggest that students who secure internships demonstrate high agency, strong self-regulation skills, and high resilience, employing strategic measures such as applying early, applying to many companies, attending conferences, preparing for interviews proactively, seeking referrals, and networking. Further, such successful student interns were more involved in activities outside the curriculum such as hackathons, student clubs, and personal projects to build skills sought out by employers.

Conversely, students who did not participate in internships prioritized coursework over the employment recruitment process or faced various barriers, including low self-efficacy, part-time work or family responsibilities, transfer-related difficulties, having a fallback (Plan B), identity diffusion (low exploration and low commitment), and a lack of awareness about the internship recruitment process.

While our pedagogical intervention of mock technical interview exercises helped mitigate some of these challenges, it alone was insufficient for securing internships. Students emphasized that ongoing practice and sustained effort post our intervention were necessary to successfully secure internship opportunities.

We also found that students who participated or did not participate in internships primarily fell into the moratorium (high exploration, low commitment) or achieved (high exploration, high commitment) identity statuses and all statuses, except diffusion (low exploration, low commitment), failed to predict internship participation in computing.

Our findings highlight the importance of student agency in career recruitment, particularly in internship applications, interview preparation, and extracurricular engagement. This work contributes to computing education literature empirical knowledge on computing students' participation in internships, which has the potential to increase students' competitiveness for employment outcomes and align our degree programs to student goals.

CHAPTER 1
INTRODUCTION

When I joined the doctoral program, I was interested in understanding how students form professional identities in computing. For exploring this phenomenon, my initial work identified how computing education researchers conceptualize or operationalize identity [86], how students describe their professional identities [78], the factors and avenues that influence their identity formation processes [83], and the chronology of this process [83] in the context of computing undergraduate programs. This research provided insight into the crucial role played by informal and non-formal learning environments such as internships, personal projects, student organizations, and hackathons on students' identity formation. Previously, most researchers working in this area had focused on understanding identity formation [15, 99, 100, 129–131, 147] by assessing students' involvement in academic degree programs. However, based on findings from my first study [83], I decided to explore computing students' participation in internships given their role in professional identity formation and their impact on students' professional careers.

An internship is a professional learning experience that provides students with an experiential learning opportunity to gain practical skills related to their field of study or career choice [73, 145, 146] for a limited period of time in a low stakes environment. It allows students to explore their chosen discipline, acquire new skills, and gain authentic experience through interactions and engagement with broader communities of practice and become members of the community [146]. For employers, internships offer the chance to bring new ideas into their workplace, nurture talent, and possibly identify future full-time employees [152].

Internships evolved from apprenticeships and modern-day internships were first offered in 1889 in the context of medical education [162]. Internships have been studied extensively in several domains such as nursing [34], psychology [154], management [35], business [64], education [148], etc. Within computing, in the early 1970's, internships provided students with hands-on experiences to work with a computer or allowed them to gain insights into industry expectations [168]. Universities facilitated internship programs coordinating with industry partners [150]. The importance of internships in computing has been documented and discussed since as early as 1974 by Goddard [57] who suggested that internships prepare students for industry jobs and recommended administrators to integrate internships more formally in computer science (CS) curriculums. For the integration of internships in formal education, Jones [75] described in 1975 a university program that required students to participate in co-op or internships for credit "after the data structures course". However, there weren't many employers who offered such opportunities and hence Archibald and Katzper [4] recommended that industry stakeholders should offer more paid internships for preparing computing students for their jobs.

More recent work on internships in computing have focused on exploring the value students get from participating in internships [114] or developing academic scaffolded programs that provide students with value that professionals may otherwise receive from internships [54, 111]. *While most of this work is focused on understanding the value of internships and developing interventions that foster these values in the context of formal academic programs, we do not know much about who is participating in the real-world internships in computing.*

My dissertation aims to fill this gap by systematically assessing computing undergraduate students' participation in internships. Note that securing a real-world intern position related to computing in the tech or other industries is competitive, and the recruitment process broadly subsumes stressful and infamous technical interviews [11, 12, 63]. The central research question I aim to answer through my doctoral work is "***How do computing undergraduate students secure and participate in internships? What barriers prohibit them from participating in internships?*"**. In this dissertation, I present four studies that I have already published in six peer-reviewed conference papers. The data for these studies was gathered through surveys and interviews from over 1,400 undergraduate computing students at three universities in the United States. Overall, **my work contributes to computing education literature empirical knowledge on computing students' participation in internships.** This knowledge has the potential to improve students' employment outcomes as well as align our degree programs to student goals.

Study 1 & 2: Understanding Student Preparation and Participation in Internships. The first two studies and their findings (1) emphasize the significance of internships in computing based on student experiences, and (2) provide an empirical assessment of students' participation in internships underscoring who participates, who does not participate, and how participation gets influenced by students' preparation processes or other situational barriers. Based on these studies, we found that a majority of our students are not participating in internships due to cognitive, psychosocial, and socio-economic constraints. This led to several questions: *How do we get these students to participate in internships? How do we improve our programs so students* *can participate more? How do we improve our programs so that those who can't participate, can acquire the skills needed to secure a full-time job or have a successful professional career?* The latter question reinforces John Dewey's ideas who argued that in order for education to be most effective, content must be presented in a way that allows a student to relate the information to prior experiences, thus deepening the connection with this new knowledge [48, 140, 166]. Are we as educators doing our part to create ample prior experiences so that students have a smooth transition to an industry role without necessarily having internship experiences?

Study 3: Intervention & Evaluation. For my third study, I focused on answering these questions by preparing students to secure jobs in industry and make the transition to industry as seamless as possible by improving our curriculum. **Study 3 describes and evaluates a pedagogical intervention for our curriculum called *Hire Thy Gator Technical Interview Exercises* that can prepare students for securing internships.**

Study 4: Retrospective Evaluation of Intervention. For my fourth study, I evaluated the efficacy of my intervention using a retrospective survey-based study that aimed to answer the following research question: ***How effective are Hire Thy Gator Technical Interview Exercises in preparing computing undergraduate students for securing industry internships?***".

Organization of this Dissertation. Since I have published most of this research, my advisor and I decided to organize this dissertation as a compilation of my published work. This work has focused on understanding the factors that contribute to successful and unsuccessful pursuits to secure internships for undergraduate computing students and designing and evaluating an intervention to support all students in their internship preparation within their degree coursework. As such, each of the four studies is presented as a chapter (Chapters 3-6).

At the beginning of each study chapter, I briefly describe the study, research questions, cite the publications that resulted from that study, and highlight the papers that I have combined to create the chapter's content. Thus, each study chapter is organized as a conference publication with an introduction, background/related work, methods, results/findings, discussion, and conclusions. I then describe the resulting research questions that guide subsequent work. Thus, I have reused the text published in these papers as well as written new text that synthesizes multiple papers together to ensure that chapters read coherently. Given this presentation style, we have decided not to include lengthy introduction and related work chapters as each study chapter identifies the motivation for the work, problems of practice and research they address, and reference different aspects of the computing education literature. In addition to four chapters describing the respective studies, Chapter 1 provides an overview of the problem and motivates the reader to explain why our work is important. Chapter 2 covers theoretical grounding that describes the theories that guided our research studies. Lastly, Chapter 7 discusses the contributions of my work and the concluding remarks.

CHAPTER 2
THEORETICAL GROUNDING

Our exploration into the characteristics of individuals who have been and have not been able to obtain internships is rooted in agency as described by Bandura's Social Cognitive Theory [6], Lent et al.'s Social Cognitive Career Theory [25, 93] which builds on Bandura's theory, and James Marcia's theory of identity development [104]. 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. These theories informed our studies' research questions, data collection instruments, and qualitative data analysis process which are described in Chapter 3-6.

2.1 Bandura's Social Cognitive Theory

Self-efficacy is the belief that one has about their capacity for specific achievements, given domain-specific obstacles [5, 7]. 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 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 [8]. *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 [8]. Last, *self-reflectiveness* lets an individual examine their functioning meta-cognitively and make corrections accordingly for future actions [8].

Bandura states that people who develop their competencies and self-regulatory skills are more successful in realizing desired futures, than those with less developed agentic resources. We use this theory to interpret our qualitative and quantitative data on students' internship seeking behavior and design our intervention that promotes the development of an individual's agency or one of its core properties. For instance, in an intervention presented in Chapter 5, students were asked to participate in mock interviews to promote self-reflectiveness and self-reactiveness.

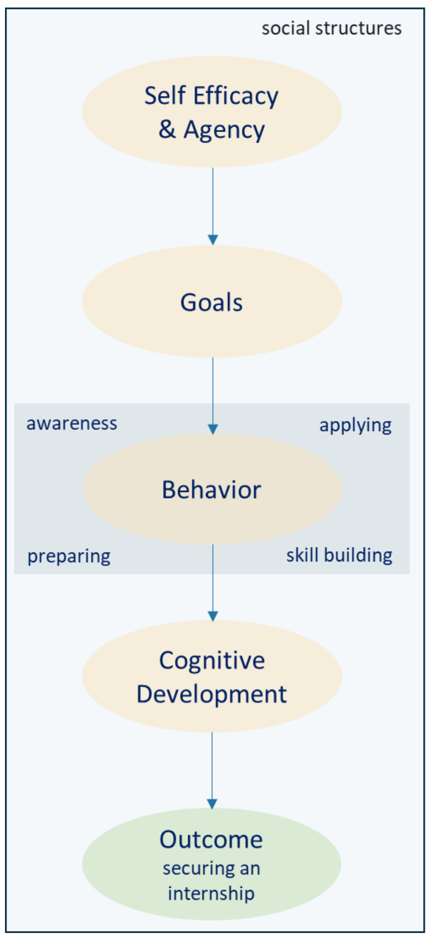


Figure 2-1. Our theory of change for internship seeking based on Bandura's Social Cognitive Theory

We believe that securing an internship position (a desired future outcome) requires 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 (see Figure 2-1). Demonstration of an individual's agency or agentic properties can be identified through action proxies including students' behavior of intentionally applying for internship positions, preparation for technical interviews, or students' agency to develop technical and professional skills that are sought by employers. On the contrary, students who are not participating in internships may lack forethought, intentionality, or other agentic resources or may not have access to social structures that foster the development of agency.

2.2 Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) models and explains the three primary mechanisms that promote career exploration and attainment: self-efficacy, outcome expectations, and performance goals [93]. 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 [93]. 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 [93].

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. We used this theory to guide the development of our data collection instruments, the survey and the interview scripts. Specifically, we gauge if and how students are exposed to “direct, vicarious, and persuasive” experiences during the 4+ years in their degree program that foster professional growth and improve their employability.

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 impediments during career exploration and attainment. Moreover, as individuals engage in the process of career exploration and skill development, they also encounter other obstacles e.g., financial, cultural, systemic, or have varying levels of support from influential others [93]. Therefore, in our data collection instruments we specifically added questions to understand the obstacles students face during employment process and will shed light on these barriers as a part of my work (described in Chapter 4).

Thus, personal agency is necessary to help individuals form performance goals and provide motivation to overcome common obstacles and barriers inherent in skill development, career exploration, and career attainment. As a part of the data analysis (described in Chapter 4), I specifically look for how agency plays a role in students’ ability to secure internships highlighting the avenues, processes, social structures, and stakeholders which foster and impede students' agency.

2.3 James Marcia's Theory of Identity Development

James Marcia's theory of identity development operationalizes stages of identity development [104] and suggests that professional identity forms during ages 17-23 based on a person's active or passive exploration and commitment to their chosen profession or discipline. The theory identifies four statuses to characterize individuals' identity development: (1) *identity diffusion*, when an individual is neither exploring nor committed to a career choice; (2) *identity foreclosure*, when an individual has not explored career options but is committed to a career due to influence of an external agent; (3) *identity moratorium*, when an individual is exploring career options but is not committed to a career choice; and (4) *identity achievement*, when an individual has explored career options and is committed to an identity after the exploration process. The theory proposes that identity develops during active exploration highlighted by the moratorium and achievement statuses.

Our first study (Chapter 3) focused on understanding professional identity formation [78, 79, 83] and we were interested in determining the unexplored relationship between identity formation and internship participation in computing in our second study (Chapter 4). To analyze this relationship quantitatively, we used the validated Extended Objective Measure of Ego Identity Status (EOM-EIS) instrument [14] which is based on James Marcia's theory of identity development [104] in Study 2 (Chapter 4). The EOM-EIS instrument provides measures to quantitatively represent identity statuses [14].

The three theories described in this section provide cognitive and situated perspectives on learning and collectively influenced our study design, research questions and instruments, and data analysis. When analyzing data, I will focus on understanding the role of task or domain-specific constructs from these theories (e.g. self-efficacy) as well as more stable and broader constructs (e.g., identity) on students' participation in internships.

CHAPTER 3
STUDY 1: WHY ARE INTERNSHIPS IMPORTANT?

I conducted my first study as a student in the master's program under the supervision of my advisor, Dr. Christina Gardner-McCune. This exploratory study was associated with the CS Identity project and focused on understanding computing students' professional identity formation at a single institution, the University of Florida. We designed this study in fall 2015 and collected data using mixed methods (a survey and interviews) in spring 2016. We analyzed the data collected from this study from 2017 and our results and findings were published in the following conference proceedings under the research papers category between 2017-2019 during my time in the HCC Ph.D. program:

1. Papers
   a) Understanding Professional Identities and Goals of Computer Science Undergraduate Student at the ACM SIGCSE TS 2018 Conference (Technical Symposium on Computer Science Education) [78].
   b) Considerations for Switching: Exploring Factors behind CS Students' Desire to Leave a CS Major at the ACM ITiCSE 2018 Conference (Innovation and Technology in Computer Science Education) [80].
   c) Understanding CS Undergraduate Students' Professional Development through the Lens of Internship Experiences at the ACM SIGCSE TS 2019 Conference [81].
   d) Understanding CS Undergraduate Students' Professional Identity through the lens of their Professional Development at the ACM ITiCSE 2019 Conference [83].
2. Posters
   a) Understanding How Computer Science Undergraduate Students are Developing their Professional Identities at the ACM SIGCSE TS 2018 Conference [79].
   b) **Deconstructing Successful and Unsuccessful Computer Science Undergraduate Interns at the ACM SIGCSE TS 2019 Conference** [77].

c) Understanding Aspiring UX Professionals' Professional Development at the User Experience Professionals Association (UXPA) 2019 Conference [82].

I was the lead author on all of the above papers and posters and Dr. Gardner-McCune was the supervisor and co-author. The publications that are bolded are described in this chapter.

Motivation & Background. In our first paper [78], we found that a majority of computing undergraduate students (82% of the 109 students we surveyed) identify themselves professionally with computing areas or job roles such as Software Engineers, Data Scientists, Cybersecurity professionals, etc. Additionally, a majority of students (65%) identified their professional goal as to secure a job in industry after graduation. One avenue that helps students in securing jobs and developing as a professional is industry internships [73, 146]. While internships have been explored in other domains [17, 34, 35, 64, 69, 148, 154], there wasn't much research on students' participation in internships in computing. Hence, we investigated how internships are valuable for students in computing [81].

In this section, I will elaborate on Paper 3: *Understanding CS Undergraduate Students' Professional Development through the Lens of Internship Experiences*, to demonstrate the value students receive when participating in real-world internships. In addition, I will shed light on our preliminary investigation of students' participation in internships through the findings from my poster, *Deconstructing Successful and Unsuccessful Computer Science Undergraduate Interns*, which was presented at the SIGCSE TS 2019 Conference as a part of the ACM Student Research Competition track [77]. This investigation motivated us to conduct Study 2 which will be discussed in the next chapter (see Chapter 4).

3.1 Overview

The US Bureau of Labor Statistics projected that by 2020 there will be 1.4 million computer science (CS) related jobs available and 400,000 CS graduates with the skills to apply for those jobs [172]. In addition, CS jobs are projected to grow at 13% over the next decade [70]. While academic institutions are working to keep up with surging enrollments to educate students to address the increasing industry demand [27], 26% of the recent CS major graduates are underemployed in the United States according to a 2018 report by the Federal Reserve Bank of New York [173]. This suggests that current CS graduates may be underprepared to secure computing jobs, thus exacerbating the current challenge the US educational system is facing in attracting and preparing enough CS students to satisfy this demand. As academic institutions, our role is to create pathways for career preparation through our degree programs to help students gain entry into various computing communities of practice (CoP) [161] and to make their transition from college to the industry as effective as possible. One way that students access these CoPs is through internships. Internships allow students an opportunity to undergo experiential learning thereby enhancing an undergraduate’s intellectual, personal, and ethical growth [55].

While internships have been extensively studied in other disciplines [17, 34, 35, 64, 69, 148, 154], research on internships in computing is limited. Therefore, in the study presented in this paper, we focus on understanding the impact that computing internships have on students’ career goals. In addition, we investigate students’ perceptions of our curricula’s effectiveness for preparing them for jobs in the industry and the strategies students incorporate for professional success. We present a thematic analysis of open-ended survey responses of 40 CS undergraduate students in the

United States who participated in an internship. We found four themes on the impact of internships on CS students. Internships: (1) *strengthened students' commitment to their CS degrees and careers*; (2) *encouraged exploration of CS careers and industries*; (3) *promoted personal/professional growth*; and (4) *developed awareness of professional expectations*. We further analyzed students' perception of the curriculum's effectiveness in preparing them for CS careers and found that students had mixed opinions on the effectiveness of computing curricula in preparing them for industry. We also observed that students were strategically working outside of their coursework to improve their technical skills and secure future employment. Our work provides insight into CS students' professional development process. This knowledge has the potential to reduce the gaps between academia and industry, thereby increasing CS students' competitiveness in the workforce and retaining them in computing degree programs.

3.2 Theoretical Background: Situated Learning, Communities of Practice

In the context of undergraduate degree programs, internships are one avenue for students to initially participate in computing communities of practice (CoP). Lave and Wenger's Situated Learning theory describes how individuals acquire professional skills through co-construction of knowledge when interacting in a social context, apprenticeship, or CoP [91]. Wenger states that "*Communities of practice are formed by people who engage in a process of collective learning in a shared domain of human endeavor: a tribe learning to survive,[...] a clique of pupils defining their identity in the school [...]. In a nutshell: Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly*" [17]. Wenger's CoP research extends research on apprenticeship [161], Situated Learning theory [91], and legitimate peripheral participation (LPP) [161]. The learning that takes place in these CoPs is situated in a specific context or environment and involves more than the acquisition of skills and knowledge. Learning in a CoP involves a change in a person's identity as well as in how a person understands themselves in relation to a particular disciplinary practice (e.g., computer science).

The theory of legitimate peripheral participation describes how members of CoP start off on the periphery of the community as a newcomer. As newcomers gradually gain understanding and mastery of key skills and practices valued by the community, they become more central to the functioning of the community and are eventually recognized as old timers within the community [161]. Throughout this process of participation in the community, members' identities are reconstructed and transformed as they seek to become full practitioners within the community. While there are official pathways to earning credentials to become part of most professional CoPs, participation in the community is essential for recognition, acceptance, and membership within the community [161].

In the context of computing CoP, internships offer students who are newcomers to the computing industry a way to become members of a community by allowing them to participate in simple tasks that further the goals of the community/organization. Through these peripheral activities, computing students become acquainted with the tasks, vocabulary, and organizing principles of the computing community and its practitioners. This theory was used to design our study and understand the impact the internships have on students' professional identities and career development.

3.3 Related Work

3.3.1 Role of Internships in Future Employment

Internships have become an integral part of employers' recruitment process as they provide them the ability to evaluate potential candidates over an extended period of time in a working environment [117, 145]. Studies have shown that pursuing an internship is positively correlated with an improved chance of getting a full-time job offer and a higher starting salary [117]. A 2017 National Association of Colleges and Employers (NACE) survey reported a staggering 91% of employers considered candidate experience when making hiring decisions and half of the employers sought new graduates to be hired from an internship or a co-op program [174]. In addition, NACE also surveyed 44,000 students in 2014 and found that 52.1% of students with an internship or co-op who applied for jobs received at least one offer of a full-time position compared with 38.6% of applicants without the internship or co-op—a difference of 13.5% [117]. Thus, it is evident that internships are playing a key role in preparing students for their professional careers and helping them to obtain full-time positions. However, little is empirically known about the impact these internships have on computing students and how effective are our programs in preparing students to secure and excel in industry internships.

3.3.2 Existing Research in CS Undergraduate Professional Development

Most research in professional development for CS undergraduate students has focused on the professional development of students through participation in capstone courses [124, 126] or project-based courses [46], or experience in internship programs developed through industry-academia partnerships [54]. This research includes Fryling et al.'s study [54] on the introduction of an internship program for upperclassmen at

Siena College. They found that a department-scaffolded internship program had a positive impact on CS student’s retention. In addition, Parker [126] did a study to understand the influence of a software engineering capstone course at an R1 research institution in the US on professional identity formation. He categorized students’ responses and artifacts using the “Becoming an Engineer” framework and found that students identified themselves with CS professions and explored career options through the capstone project. Parker also did a study on understanding professional development through capstone projects and found that students’ affective responses during their capstone projects provide an indication of their engagement and investment in the CS projects [125]. Tomer and Mishra [159] interviewed students in a prominent university in India and found that CS students described a noticeable gap between their academic training and their internship experience which led them to have mixed satisfaction with their CS degree program and the program’s role in preparing them for their future careers. Our work however focuses on a different context, real world industry internships in the United States and we plan to investigate the impact of internships on computing undergraduate students.

3.4 Methods

3.4.1 Study Design

We designed a cross-sectional survey-based study focused on understanding the impact that professional internships have on: CS students’ career goals, students’ perceptions of the gaps between academia and industry, and students’ strategies for professional success. 97 students enrolled at a R1 public university, University of Florida participated and completed a survey in spring 2016. The university had a population of 1519 undergraduate CS majors in 2016. The CS undergraduate degree program offered at the University of Florida allows students to major in CS or Computer Engineering (CE). The students can choose a major when they start college but can change it at any time. For this paper, we report on the data of 40 CS undergraduate students who participated in an internship. In this paper, we focused on exploring the following research questions:

RQ1. How do professional internships impact CS undergraduate students?

RQ2. What lessons can we learn from CS undergraduate students' professional experiences that can strengthen our academic curriculum?

RQ3. What lessons can students learn from CS undergraduate students' professional experiences that can aid to their professional success?

3.4.2 Participant Recruitment

Students were recruited from the University of Florida's CS1, data structures, software engineering, senior design, Human-Computer Interaction courses and several CS technical electives. The survey participants were given extra credit for participating in this study - not more than 1% towards their final grade based on pre-approval by the respective course instructors. Additionally, students were given an alternate assignment worth similar credit if they opted out of the study. The second author (Dr. Gardner-McCune) was one of the instructors who offered extra credit in the software engineering course, but the data was collected by the first author (myself) and not shown to the second author until after grades were submitted for the course.

3.4.3 Participants

The age range of the participants was 18 to 23 based on the enrolled CS undergraduate population at the University of Florida. The details of the survey respondents are as follows: 148 students responded to our survey; 102 students completed more than 94% of the survey. Out of the 102 students, 5 students did not major or minor in CS or CE. Thus, we were left with 97 CS/CE undergraduate students. Of these 97 CS students, 41.2% participated in an internship (n=40). Further, we found that an equal proportion of males and females in our survey sample participated in internships: 40.9% of 22 females (n=9) and 40.5% of 74 males (n=30). The students who interned included 1 freshman (6.3% of 15), 57.1% of 14 sophomores (n=8), 44.8% of 29 juniors (n=13), 42.4% of 33 seniors(n=14), and 80.0% of 5 super-seniors (n=4). For this paper, we exclude the data for students who did not have prior internship experience as we want to explore what students get out of internships.

Thus, we report data on 40 CS undergraduates (41.24% of 97) who completed more than 94% of the survey and had internship experience. These students consist of 30 males and 9 females. One student did not report gender. The students who interned included 1 freshman, 8 sophomores, 13 juniors, 14 seniors and 4 super-seniors (4+ years in the program).

3.4.4 Data Collection

We gained consent from the Institutional Review Board at the University of Florida and used Qualtrics to administer the survey. The participants were asked to complete a consent form prior to the survey. The survey consisted of 3 demographic-related, 36 multiple choice, and 16 open-ended questions and was completed on average within 32 minutes. For this paper, we focus on 6 open-ended questions that are relevant to answering our research questions (see Table 3-1). We also use three demographic questions on gender, major, and academic standing and one multiple choice question on whether they participated in an internship.

Table 3-1. Survey questions analyzed for answering research questions (as reported in Kapoor & Gardner-McCune, SIGCSE 19)

Research Question	Survey Questions
RQ1. How do professional internships impact CS undergraduate students?	Describe the impact of internship experiences on your career goals and interests.
RQ2. What lessons can we learn from CS undergraduate students' professional experiences that can strengthen our academic curriculum?	* How well has the CS curriculum here at the university prepared you for industry and/or research professional experiences? * Can you think of a course whose use/application was way different in the industry than as taught here at the university? * Describe your experience in the CS/CE degree program? Reflect on the quality of your academic experience. * Please provide additional comments or suggestions for improving the degree program and experience at the university.
RQ3. What lessons can students learn from CS undergraduate students' professional experiences that can aid to their professional success?	Reflecting on your degree experience, what advice would you give to students enrolled in this program to improve their experience in the program and their professional success?

3.4.5 Data Analysis

We analyzed student responses to six open-ended questions using inductive thematic analysis in Microsoft Excel. We were following a grounded theory process of inductive coding [41]. We started with the raw data and created codes inductively using words from participants' responses. The first author created primary codes which were then clustered to form categories, and these categories formed the basis of our codebook (see Table 3-2). We coded 129 student responses into 150 primary codes, which were clustered to form 78 categories. We then combined these categories into themes. 11 themes emerged to answer our three research questions: 4 for RQ1, 4 for RQ2, and 3 for RQ3.

To verify the reliability of the first author's coding scheme, the second author performed the inter-rater reliability at the theme level on 36% of the dataset chosen at random. The Cohen's Kappa was an average of 0.72 for the coding scheme which qualifies as a substantial agreement [90]. The authors discussed the themes in which there was a disagreement until a consensus was reached about the theme accuracy and reliability. Table 3-2 highlights an example of our inductive content and thematic analysis [41]. 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. There were some participants whose responses belonged to more than one theme and thus the percentages don't add up to 100%.

Table 3-2. Example of inductive content and thematic analysis (as reported in Kapoor & Gardner-McCune, SIGCSE 19)

Survey Question: Have you participated in any internships? If yes, how did it affect your career goals and interests?			
Raw Data	It made me *like my career* even more.	It made me *not want to change my CS major* anymore.	Helped me to *decide on CEN* [Computer Engineering].
Primary Code	Like a CS career	Not change a CS major	Choosing Computer Engineering
Category	Strengthened to pursue a CS career	Strengthened to pursue a CS major	
Theme	Strengthened students' commitment to CS degrees and careers		

3.5 Findings/Results

3.5.1 Impact of Professional Internships

We analyzed student responses to an open-ended survey question: *Have you participated in any internships? If yes, how did it affect your career goals and interests?* Thirty-four students who interned responded to this question. Four themes emerged from our data analysis on the impact of professional internships on CS undergraduate students’ career goals (RQ1). These themes and their respective frequencies are shown in Table 3-3.

Table 3-3. Themes for impact of internships on career goals (as reported in Kapoor & Gardner-McCune, SIGCSE 19)

Themes for impact of internships on career goals	n (N = 34)	%
strengthening students’ commitment to CS degrees and careers	14	41.1%
encouraging exploration of CS careers & industries	12	35.3%
promoting personal/professional growth	6	17.6%
developed awareness of professional expectations	5	14.7%

Strengthening students’ commitment to CS. We found that internships played a crucial role in strengthening CS students’ commitment to pursue a CS major or CS careers. 41% of 34 students (n=14) mentioned that the internship had a positive impact on their career goals: strengthened their career goals, instilled in them interest in CS, or made them determined to pursue a CS major. The two most prominent categories in this theme included: *strengthened their commitment to pursue a CS career* and *strengthened their commitment to pursue a computing major*. All three students who belonged to “strengthened to pursue a CS major” category were either sophomores or juniors. Representative quotes from students belonging to this theme include:

> - It has given me experience as well as encourage me to stay with computer science - Male, Senior
>
> - It made me not want to change my CS major anymore - Female, Sophomore
>
> - It made me more determined to get my degree in CSE - Male, Junior

Encouraging exploration of CS careers and industries. Within this theme, we found that internships were allowing CS undergraduates to explore areas within CS as well as industries or work cultures within different types of companies. This exploration led 35% of 34 students (n=12) to determine their interests and dislikes. 58% of 12 students (n=7) whose responses were coded in this theme had a negative experience and wanted to avoid a CS area such as Information Technology or Web Development or a certain type of company or industry like military or an established corporation after their internship. On the other hand, 33% of 12 students (n=4) had a positive impact and wanted to work for the same company or a CS area. One student had both a positive impact to work in an area as well as a negative impact to avoid a certain area. Those who had a negative experience were willing to explore a different area in the future. Some representative quotes from this theme include:

> - It significantly affected my career goals. It made me more interested in simulation and in working for government contracted companies - Male, Senior

> - I know more about what interests me and which fields of study to avoid - Female, Sophomore

> - I have interned as an IT tech for a construction company. It made me not want to work in IT ever again - Male, Junior

Promoting personal/professional growth. In this theme, students explained that internships helped them to grow personally as well as professionally. The personal growth was not only limited to an increase in their knowledge and skills, but the students' responses also pointed out evidence of growth in dispositional temperament including confidence and responsibility. This growth had an agentic influence on students' behavior helping them to pick future courses or decide CS specialization areas. The internship also provided them with an opportunity to get subsequent job offers.

> - [My internship] Taught me to teach myself things - Male, Junior

- I loved my internship. It finally made me confident about my abilities in computer science - Female, Senior

- Lead to the acquisition of a post graduate job - Female, Senior

Developed awareness of professional expectations. CS students who participated in internships indicated that internships shaped their outlook on the tech industry, and they gained awareness about professional expectation in the industry. Students explained that internships provide them with a new perspective on working in the industry and their CS degree.

- It allowed me to see what it was like working in a professional environment and how working in a company would be – Gender not specified, Sophomore

- It helped me understand how the industry works actually. I did realize that I might not want to do the work I was doing in my internship but look at something else - Female, Senior

3.5.2 Students' Perceptions of the Effectiveness of Their Degree Program

To gauge students' perception of their curriculum's strength in preparing them for the professional experiences, we asked them: *How well has the CS curriculum at the university prepared you for industry and/or research professional experiences?* We found two primary themes: *effective* and *needs improvement*. In addition, 9% of 38 students (n=3) who responded to this question were *not sure* about the program's effectiveness.

Effective. 47% of 38 students (n=18), considered the curriculum to be "effective" in preparing them for professional experiences. These students felt that the curriculum prepared them exceptionally or adequately for developing skills, securing jobs, or getting calls for interviews. Students also pointed out that the curriculum has prepared them to learn new topics, as well as advanced classes were effective in preparing them for the industry.

> - Pretty well I'd say. It has taught me to teach myself how to code in new languages at least - Male, Senior

> - It has prepared me enough to land me a job [internship] at Lockheed - Female, Freshman

> - Decently well, judging from interviews - Male, Junior

Needs improvement. 45% of 38 students' responses (n=17) were categorized into the "needs improvement" theme. In this theme, students reported that the curriculum fairly or poorly prepared them for their professional careers. In addition, students found the curriculum to be more geared towards preparing them for graduate school or research, and several other students perceived their prior knowledge or self-initiatives to learn new languages and tools were necessary for preparing them for their future careers.

> - The curriculum is more geared towards students pursuing graduate school or research - Male, Junior

> - Only somewhat. It's been mostly personal investment in different technologies. [University] only provides the "paper" that allows you to get in the door. The rest is on you - Male, Sophomore

> - It gave me some good base knowledge of things, which is helpful. But all of the tangible skills that I have that actually earned me a job, were self-taught or taught to me by another entity - Male, Junior

To better understand the CS students who reported that the curriculum needs improvement, we used their comments from several questions in the survey where they explained how academia was different from the industry. Thirteen students provided feedback on the distinction. We found two themes which answered RQ2. These themes included the *need for a broader curriculum* and *better alignment between languages, tools, and frameworks used in industry and academia*.

Need for a broader curriculum. Six CS students mentioned that the CS academic degree programs need more industry or job-related courses, and holistic improvement of pedagogical practices at the program level. The key issues students emphasized in this theme included offering more tech electives, fewer general education credits, optional hardware courses, and including practical applications in theory heavy courses.

> - Better balance of theoretical and skill driven CS skill and more app development classes - Male, Junior

> - For my internship, I taught myself two languages and used little of what I learned in school. I wish the CS department would teach more real-world applications of code and teach both coding and concepts in lecture rather than deeply relying on concepts and letting you figure out the rest on your own - Female, Senior

Better alignment between languages, tools, and frameworks used in industry and academia. Seven CS students stated that a programming language, framework, tool, or methodology used in academia was not used in the industry. They commented on the ubiquity of the agile software development model and less usage of languages like C++ and Java in the industry.

> - Another thing I think should be changed is the focus on C++. In my first couple years here, I thought C++ was this great language and it would come in handy to know it well since I was using it in multiple classes. Then, when I went to interview with companies, not a single one even touches the language. I think it’s important to teach a C-based language to have that experience, but it should be limited to one class. There are so many other languages in which knowledge of them will actually benefit us, that we should be using - Male, Junior

3.5.3 Student Strategies for Professional Success

Our third research question focused on the lessons students can learn from professional and academic experiences that can help other students for their professional success. 37 students responded to a question: *Reflecting on your degree experience, what advice would you give to students enrolled in this program to improve their experience in the program and their professional success?* We found 28 unique categories from 37 student responses. Three themes emerged from these categories: *Work outside curriculum*, *Be strategic in coursework*, and *Have social supports and a network*.

Work outside curriculum. In this theme, 54% of 37 students (n=20) recommended that their peers do work/learn outside the CS curriculum. Prominent strategies in this category included: learning outside school (n=8), getting involved with student organizations (n=7), doing side projects (n=6), learning to program for interviews and industry (n=5) and doing internships (n=4).

> - Do personal projects and get experience working on a team. Always strive to learn more - Female, Sophomore
>
> - Do a lot of practice in your free time by visiting programming contest websites (SPOJ (Sphere Online Judge) and the likes), watch YouTube videos, but most importantly GET INVOLVED - Male, Junior
>
> - Sign up for the right professors, get an internship early, get really good at learning outside the classroom - Male, Senior
>
> - I would encourage other students to get internships to experience what the computing field is actually like. The classes at university don’t give a good indication of what it’s like to work in the professional field at all - Female, Sophomore
>
> - School is not enough to be successful in this field, you must learn a lot on your own and topics that are being discussed/introduced in the industry - Male, Junior

Be strategic in coursework. In this theme, 54 % of 37 CS students (n=20) suggested strategies to follow during the CS degree program. Prominent strategies in this category included: taking courses offered by specific professors (n=6), working hard and not procrastinating (n=6), taking courses with projects and working hard in them (n=3), teaching yourself before classes (n=2), taking courses to determine interests (n=2) and taking electives in areas of interest (n=2).

> - Take a wide variety of courses early to find out what does and does not interest you. Don't seek electives that are easy, but rather interesting - Male, Senior

> - Work hard on your projects and make sure to do a good job, as opposed to just doing what you need to do to get by. If you slack off you will have a lot of catching up to do before attending and interview or actually going to a job - Male, Junior

Have social supports and a network. In this theme, 24% of 37 students (n=9) advised other students to make friends in CS/classes, talk to TA's and Professors, attend office hours, do networking, and take advice from seniors for professional success or a better CS degree program experience.

> - Make lots of connections. Make friends with your TAs, professors, and classmates. It makes the course so much more enjoyable and easier - Female, Freshman

> - I would suggest them to talk to professors and their seniors and try various things in their initial years to figure out what they like and then focus on that field in the later years - Female, Senior

3.6 Discussion and Conclusion

Our paper contributes to the CS professional development literature in the following ways:

Explaining the impact of internships on CS students' career goals. Our findings suggest that industry-based internships are playing a crucial role in retaining

CS students in computing programs, promoting exploration of different areas of computing and computing careers, and intentional exploration of technical electives. This role is crucial as prior research has shown that CS students have misconceptions about computing and that many undergraduate students are not intentional about their selection of technical electives and courses [16, 66–68, 108]. In addition, our findings extend prior results from researchers at the Siena College [54] who found that a department-based CS internship program had a positive impact on student retention for upperclassmen. Despite the benefits students found from participating in internships, findings from our study give cause for alarm as only 41% of CS students in our sample participated in at least one internship experience. We have found that these numbers are similar across junior (44%) and senior years (42%). Results from a Gallup-Purdue Index revealed that 61% undergraduate students use career centers for internship search assistance [117]. Thus, further research is needed to better understand: (1) the characteristics that differentiate successful internship applicants from unsuccessful applicants and (2) why students, especially juniors and seniors have not had at least one internship experience, given that companies give preference to students who have had internship experiences for full-time jobs [117, 145, 174].

Analyzing students' perception of the effectiveness of CS degree programs in preparing them for their professional careers. Overall, we found mixed responses from students completing at least one industry experience: 48% of the students felt that the curriculum is effective, and 47% CS students felt that the curriculum needs improvement in preparing them for the internships. Nationally, one-third recent U.S. college graduates strongly agreed that their internship allowed them to apply what they were learning in the classroom [175]. Internationally, Tomar and Mishra [159] interviewed students in a prominent university in India and found similar patterns of mixed satisfaction and dissatisfaction with their CS degree program's preparation for industry experiences. Students in our study recommended that the CS curriculum needs to be broadened to include more courses in web or app development, more practicality and project-based learning coursework, the agile methodology of software development in coursework, and more relevant programming languages that are used in the industry. These findings confirm a prior study's finding on the perceptions of employers about the gaps between CS industry and academia that found employers reporting recent graduates to be struggling with software tools, ineffectively communicating with their co-workers and customers, and having a lack of project experience [138, 139]. These issues prevent students from gaining employment. This suggests that degree programs need to ensure that these gaps are minimized to better prepare our students for jobs in the industry and thereby satisfy the demand for CS graduates in the industry. Additionally, the findings suggest that computing academic programs offer different communities of practice [161] than what students' experience during an internship and one avenue that may act as a bridge between these two communities is computing clubs which focus on skill and professional development.

Identifying the strategies that CS students recommend for professional success. Overall, we found that students were working outside academia to gain additional skills needed to secure an internship or a full-time job. Moreover, they were recommending these strategies to other students. Thus, we need to better understand what skills students are gaining outside of our curriculum to help them secure industry internships. Then we need to evaluate which skills and experiences we can integrate into our coursework so that all students can benefit from it and are provided with access to such resources in every university. We also found that students are strategically working within their degree program and are forming a social support system consisting of friends in their major and professors and TAs, as well as are networking to attain professional success and be prepared for their professional careers.

Recommendations. Based on our findings, we recommend that students pursue at least one CS internship prior to completing their CS degree program. We also suggest that departments make internships mandatory for CS degree graduates given the role they play in students' professional development as well as the industry's predilection towards applicant's prior experience in the new graduates' recruitment process. Further, we recommend that departments ensure that their CS curriculum is effective in balancing theoretical and practical applications in computing, thereby preparing students for industry jobs, and reducing the demand for lack of CS graduates for technical jobs in the industry.

3.7 Limitations

The findings from this study represent a snapshot of the internship experiences taken from a small sample of CS students at a large US-based R1 university. Hence, the findings may not generalize to large populations of students at similar or different institutions or experiences of CS students in other countries. In the future, additional data on students' GPA, type of internship - paid or unpaid, area of internship and type of company they worked for, might help to better characterize the population. Additionally, our sample consists of students who are enrolled in computing programs and are prone to survivorship bias. There is a chance that students who left the computing discipline may have had negative experiences in industry and are not present in our sample. Future investigations can explore the students' experiences in industry who left a computing major or the discipline altogether. Another limitation of our study is that qualitative analysis relies on interpretation, which can introduce subjectivity. Different researchers may interpret the same data differently, leading to variations in findings. However, to improve validity and reliability, we have described our thematic analysis process and provided participant quotes for transparency. Lastly, given that this study gave students extra credit at the end of the semester, the study population could be skewed towards high performing students that wanted to take every opportunity to secure a good grade in their course or low performing students that wanted an extra grade boost.

3.8 Subsequent Study

From this study, we learned that internships play a crucial role in helping computing undergraduate students to commit to CS majors, degrees, and careers, understand professional expectations, explore the discipline, and provide authentic opportunities for self-evaluation. However, only a minority of students (41%) in our sample participated in an internship before graduation. Therefore, we did preliminary analysis on the data collected from this study to understand the characteristics of CS students who have interned at one or more companies and those who have not interned. This analysis was presented at the ACM SIGCSE 2019 conference as a part of the graduate ACM student research competition [77] where we found differences in students' career goals, participation process in external activities such as undergraduate research experiences or student clubs, and preparation practices for securing internships between students who interned and those who did not. This work was awarded second place in the graduate category at the competition. To collect more evidence to corroborate our findings, we designed a subsequent multi-institutional study, targeting a larger sample, to empirically investigate the differences between students who secured internships and those who did not which is described in the next chapter.

CHAPTER 4
STUDY 2: WHO IS PARTICIPATING IN INTERNSHIPS AND HOW?

Given the benefits computing students were receiving from internships (Chapter 3), it was concerning that only a minority of students (40%) were participating in internships. Therefore, we wanted to investigate how students were participating in internships. Specifically, my dissertation will answer the following research question: ***How do computing undergraduate students secure and participate in internships? What barriers prohibit them from participating in internships?*** This chapter will describe analysis regarding this research question, and I will highlight the findings from three published papers describing students who participate in internships, students who do not participate in internships, and the factors that are associated with students' participation in internships.

My advisor, Dr. Christina Gardner-McCune, and I applied for the SIGCSE Special Projects Grant to scale the CS Identity project in May 2018 and assess students' professional identity formation in the context of academic programs, professional development opportunities, and informal learning avenues. We were awarded a grant for the "*CS Identity Development Interview Project*" in June 2018, and we planned and ran our second study between August 2018 - December 2019. This study was multi-institutional and used mixed methods (surveys, interviews, and artifacts: resumes). Data was collected from 767 students who participated in a survey and 42 students who were purposefully recruited for semi-structured interviews at the University of Florida, Georgia Institute of Technology, and Rose-Hulman Institute of Technology. These institutions were selected to understand how student participation in internships varied across two similar large R1 public institutions and one dissimilar small private undergraduate teaching focused institution. We analyzed the survey data collected from this study from 2019 and our results and findings were published in the following conference proceedings under the research papers category between 2019-2023 during my time in the HCC Ph.D. program:

1. **Paper 1 Who Participates and Preparation Practices**: Exploring the Participation of CS Undergraduate Students in Industry Internships at the ACM SIGCSE TS 2020 Conference (Technical Symposium on Computer Science Education) [84].
2. **Paper 2 Barriers to Participation**: Barriers to Securing Industry Internships in Computing at the ACM ACE 2020 Conference (Australasian Computing Education Conference) [76].
3. **Paper 3 Factors Influencing Participation**: Modeling Determinants of Undergraduate Computing Students' Participation in Internships at the ACM SIGCSE TS 2023 Conference [164].

I was the lead author on the first two papers and Dr. Gardner-McCune was the supervisor and co-author. For the third paper, focused on the survey data analysis, I supervised two undergraduate senior projects for Megan Wolf and Charlie Hobson who were the first and the third authors, while I was the second author. For this paper, I contributed to the literature review, data collection, analysis, and writing. The interview data from this study was analyzed as a part of my proposed work for this dissertation (Section 4.4) and we have not yet published findings from this analysis.

The remaining chapter is organized as follows. For each section, I have consolidated respective sections from the three papers and interview data analysis to avoid redundant text given the overlaps in introduction, related work, and theoretical grounding. For methods, findings, and discussion sections, I divide the sections into subsections highlighting my approach and analysis for each paper and the interview analysis.

4.1 Overview

Jobs in computing are projected to grow at 13% annually over the next decade in the United States [176]. This growth is widening the gap between the number of computing jobs available in the industry and CS graduates required to fill these jobs [172]. The rising enrollments in computing majors [27] 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 [173]. 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 [22, 138, 139]. One mechanism that allows students to gain these technical and professional skills is through their participation in internships during their degree program.

Internships provide students with an opportunity to engage in experiential learning that enhances their intellectual, personal, professional, and ethical growth [55, 146, 156]. In addition, internships allow students to explore computing pathways, determine likes and dislikes, develop professional skills, and build professional networks in a conducive environment [81, 171]. Employers also use internships as an opportunity to evaluate potential candidates, thus deeming them crucial to the full-time recruitment process [117, 145]. Therefore, encouraging students to participate in internships may be an effective strategy for preparing students for jobs in industry and reducing the skill-deficit. However, little is empirically known about computing students' participation in industry internships and the preparation process they use to successfully secure an internship.

In this section, we present findings from our multi-institutional study aimed at understanding the participation of computing students in internships and analyzing the differences between students who intern and those who do not. We surveyed 767 computing undergraduate students and interviewed 42 of these students across three universities in the United States. From this data, we identified

1. the students that participate and do not participate in internships.
2. the impediments faced by students failing to secure an internship.
3. the differences in preparation process of students who intern and students who do not intern.
4. the factors that associate with students' participation in internships.
5. personas of students who participate or do not participate in internships.

We analyzed the quantitative data using descriptive and inferential statistical methods as well as modeled student participation in internships using a multivariable logistic regression model. The open-ended qualitative data from our survey and interviews was analyzed using inductive thematic analysis. The triangulated findings from these data sources were used to develop data-backed descriptive personas highlighting characteristics of students who successfully participate in internships and those who do not.

Overall, we found that 40% of students participate in at least one internship. Demographically, equal proportions of males and females interned. Using a logistic regression model, we found that (1) year in school, (2) household income (a proxy for socioeconomic status), (3) involvement in activities outside the curriculum, and (4) lower identity diffusion scores (i.e., low exploration and low commitment) are significantly associated with a student's participation in an internship. Quantitatively, there were no significant differences between students who intern and those who do not with regard to academic performance. However, through thematic analysis, we found differences regarding students' preparation process for securing internships. Interns explicitly prepared by practicing technical interview questions and dedicating time to career preparation. Students who did not intern were less involved in the application process, relied on coursework for securing internships, and were not applying for internship positions due to alternate priorities or less developed agentic resources such as low self-efficacy. These findings suggest that factors outside of coursework are influencing students' ability to secure internships.

Given the value students receive from participating in internships (see Chapter 3) and our findings from this chapter that a minority of students pursue internships, *our goal is to identify and disseminate how students can secure internships to stakeholders involved in the career development process and strengthen our curriculum for supporting students to secure employment*. The results of our study contribute to computing education research (CER) literature empirical results associated with computing students' participation in internships. Our work can inform CS departments about student barriers to internship participation and aid in the development of support programs focused on improving students' employment outcomes.

4.2 Related Work

4.2.1 Professional Development Opportunities for Computing Students

Employers have reported that recent CS graduates lack technical abilities, personal skills, and professional qualities [138, 139]. 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 [92]. Research in professional development for computing undergraduate students has focused on the professional development of students through participation in capstone courses [124–126], co-curricular activities [52], project-based courses [46], local community-service projects [45], part-time or remote internships [45], student experiences in industry internships [121], or work-integrated learning programs developed through industry-academia partnerships [28, 54]. This research includes Parker's study which found that software engineering capstone courses allowed CS students to explore CS career options [124–126]. In another study, Fryling et al. [54] found that a department-scaffolded internship program at Siena College had a positive impact on CS students' retention. Research on professional development through CS industry internships is limited. This research includes inquiries on understanding the role of internships in professional identity formation [105, 159] or exploring students' experiences of participating in an internship [26, 81, 114, 171]. However, there is a lack of research in the CS education research literature that focuses on gaining insights into who are the students that participate in internships and the barriers faced by those who fail to participate.

4.2.2 Benefits of Internships in Computing

Industry internships are a valuable method of gaining technical and professional skills beyond what is taught in formal academic computing classrooms. In addition, internships provide opportunities for self-evaluation, expansion of professional networks, and development of professional expectations [81, 114]. Thus, internships provide an authentic environment for addressing the industry-related skill deficit [22, 138, 139] among computing students. In addition to supporting students in skill building, internships have been shown to foster identity formation [47, 83], increase retention in computing programs [54], and improve capstone project quality [72, 121]. Lastly, employers often utilize internships as evaluation tools during the recruitment process for hiring decisions, and students who previously interned are more likely to get a full-time position and a higher starting salary [117, 145, 152, 174]. In summary, internships have been found to provide computing students with opportunities for skill building and participation in internships is beneficial for securing subsequent employment after graduation. Thus, it is highly recommended that students participate in internships before graduation.

4.2.3 Computing Internship Recruitment Process in the United States

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 are competitive, and employers make hiring decisions through a multi-stage competitive recruitment process [106]. The process typically has three stages: an application phase, an interview phase, and a negotiation phase.

During the application phase, an applicant applies to various roles and companies by submitting their resumes and answering questions through digital applications, career fairs, or company information sessions. The applications are screened through Applicant tracking systems (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. Relevant candidates are selected for the next stage which is the interview phase based on a student's experience, GPA, and involvement in projects [106, 152]. Companies invite applicants for one or more technical and behavioral interviews and there is variation in the number and rigor of the interviews depending on the job role and companies. A majority of companies ask students technical questions in an interview related to DSA, especially for software development and engineering positions. In these interviews, applicants are asked to either write programs on whiteboards or shared screen text editors and talk out loud about their thought processes when solving a problem [106, 152]. Applicants are evaluated on problem-solving skills, professional skills such as communication skills, and the ability to derive correct solutions in a limited timeframe [11, 152]. Finally, in the third stage, an offer is made by the company, and the applicant has an opportunity to negotiate. Some universities require students to pursue an internship before graduation while others have no such requirement.

4.2.4 Modeling Factors Associated with Internships

Work that quantitatively modeled students' internship participation includes a study by Hoekstra which modeled variables that predict internship participation across different undergraduate majors [69]. Her work found five significant pre-college predictors (race, gender, age, first-generation status, and future educational plans) and participation in high-impact practices such as research, learning communities, etc. influenced internship participation. According to her study, students who were Asian American, male, older, first-generation, or had lower participation in high-impact practices were less likely to have interned. Hoekstra's findings provide insight for building our model and we used several similar predictors. While Hoekstra's study generalizes across majors, we aim to extend this work by performing a similar analysis on the unexplored field of computing. Further, we include variables specific to CS curriculum and involvement as well as identity status scales as predictors.

Internship participation has also been modeled in other fields including civil engineering [59] and medical sciences [58]. These studies determined potential predictors of students' satisfaction with internships [59] or modeled attributes that determine student success in internship performance [58]. Generically across majors, researchers have also predicted final grades and degree level classification from internship experience [17] or analyzed the impact of internships on university graduation rates [74]. In contrast, our study models the inverse of these relationships as we seek to understand if higher grades or other variables are predictors of securing internships.

Researchers have also studied the relationship between identity formation and internships and have found that internships support identity formation in engineering [47] and counseling psychology [50]. Our work tries to understand the inverse relationship between identity formation and participation in an internship and we assess if a student in an identity status is more likely to have secured internships. A study in Psychology by den Boer et al. [20] investigated the association between identity formation and internship participation and found that an internship in itself did not explain individual differences in identity processes, and enrollment in an internship was largely unrelated to identity processes, i.e. there is no relationship between internship participation and identity formation. den Boer et al.'s work is similar to our study, but the authors recruited graduate students who were interns and undergraduate students who did not intern, and internship enrollment was an obligatory part of their curriculum. Our work pertains to the computing discipline, and we compare a more homogeneous population of undergraduate students who have or have not participated in internship(s). In addition, internship participation is optional in our program and hence our results might not be comparable with den Boer et al. as the population and context for the studies are different. Our results may be held in similar computing programs where internship participation is not obligatory.

4.2.5 User Personas in Computing Education Research

User personas were first introduced by Alan Cooper as a practical interaction design tool in his book, "*The Inmates are Running the Asylum"* [39] and they gained rapid popularity in the software industry for their power and effectiveness [136, 177]. Personas are archetypes of users based on actual data that narrate realistic types of users based on clusters of goals, attitudes, and behaviors [18, 19, 178]. Within Computing Education Research literature, personas have been used as (1) a *pedagogical tool* in classroom practice to describe or identify design requirements [9, 23, 24, 29, 115, 128, 149, 157, 167] or for generating awareness on social topics such as diversity [142], (2) a *conceptual tool* to guide research design and inform research study interventions [31, 94, 122, 127], (3) a *design tool* to collect data regarding a subject's decision-making process [32, 33], and as (4) an *analytical tool* to categorize or visualize empirical research data [56, 89, 113, 119, 120, 155, 170].

Research that has used personas as a *pedagogical tool* to describe or identify design requirements includes Mohan and Chenoweth's work [115] which described an innovative curriculum for software engineering or senior design courses which allows learners to gain hands-on experience on requirements elicitation and management techniques. They proposed that students should use personas for problem analysis and interact with faculty who role played as personas to elicit requirements. Letaw et al. [94] used GenderMag's personas as a *conceptual tool* to inform the design of their curricular intervention promoting inclusive design and Chinn and VanDeGrift [32, 33] used personas as a *design tool* to collect data regarding students' decision-making process. In the latter study, the researchers gained insights into students' decision-making process related to hiring in the software industry by providing students with four personas of potential hiring candidates and asking them to list their criteria for evaluating the candidates.

Work that has used personas as an *analytical tool* to categorize or visualize empirical research data include Nelimarkka and Hellas' research [119] who used personas to present a typology of social learning strategies used by five types of Massive Open Online Course (MOOC) learners. These personas described learners that had the following help seeking strategies: computer-mediated friend-based interaction, non-helpseekers, friend supported learners, heavy MOOC platform benefiters, and MOOC platform benefitters. Their goal was to communicate these personas to course instructors, MOOC system designers, and other stakeholders. Similarly, Newby also categorized online help-seeking behaviors and found two personas: askers and lurkers (those who ask and never ask questions) [120]. They observed that askers performed significantly better on course performance than lurkers. Another work that used personas as an analytical tool is research by Teague [155] who explored why students struggle learning to program using a people-first approach. She described the barriers to programming using rich case studies and student programmer personas which further formed the basis of a design taxonomy categorizing the personas across two dimensions: *confidence* and *determination*.

User personas of students who participate and do not participate in internships are developed using triangulated results from our survey and interview data analysis. Our work uses personas as an analytical tool to categorize the data similar to the work by Milliken et al. [113] who described teacher personas using cases in the context of block-based program grading or Teague's work that described student personas who faced barriers to programming [155]. Additionally, we back our personas with results from our frequency analysis of qualitative codes and use our survey results to triangulate the findings similar to Giannakos et al.'s work [56] which examined the profile of CS teachers and developed personas regarding their knowledge on Technological, Pedagogical, and Content Knowledge.

4.3 Methods

4.3.1 Study Design and Research Questions

We designed a cross-sectional multi-institutional study based on a Concurrent Triangulation Design [42] to understand how computing 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 to triangulate overlapping patterns [42]. This design supports the corroboration of findings through multiple data sources and improves validity. Our study was designed in spring 2019 after a single institution pilot study in spring 2016 [78, 81] that is discussed in Chapter 3. This study is multi-institutional and has a larger sample size (5.5x) compared to our pilot.

We analyze quantitative data from our survey and qualitative data from our survey and interviews comparing CS students who interned and those who did not. We address the following research questions in this chapter:

1. Paper 1 (who participates and preparation practices):
    a) **RQ1.** Who are the computing undergraduate students that participate in industry internships?
    b) **RQ2.** How does the preparation process of computing undergraduate students who secure an internship differ from those who do not intern?
2. Paper 2 (barriers to participation):
    a) **RQ3.** What barriers do computing undergraduate students, who do not intern, encounter in securing an industry internship?
3. Paper 3 (factors influencing participation):
    a) **RQ4.** What are the factors that influence undergraduate computing students' participation in internships?
4. Analysis of interview data
    a) **RQ5.** How are computing undergraduate students who successfully secure internships different from those who have not interned?

4.3.2 Population, Sample, and Research Sites

Our study population is traditional college students who are enrolled in an undergraduate CS-related major in the United States. Our sample is drawn from students enrolled in an undergraduate computing degree program at three universities in the US and focused on four-year CS programs targeting students across academic standing, gender, and racial/ethnic 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 institutions. 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 mid-west. This site was chosen to compare 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.

4.3.3 Participant Recruitment

Our study was approved by the Institutional Review Board at the research site. 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. A substitute assignment requiring equal effort was also provided to the students if they did not wish to participate in our research study for extra credit.

Participants for the semi-structured interviews were purposely recruited from the survey based on five attributes: (1) internship status, (2) gender identity, (3) racial identity, (4) year in program, and (5) university affiliation. These attributes were selected to capture representation of student voices regarding internship participation experiences across our study population of computing undergraduate students.

4.3.4 Participants

767 students at the three research sites responded to our survey excluding duplicates in spring and fall 2019. There are differences in the dataset for the three papers based on the time of data collection and publishing dates of the articles as well as the alignment of the data to our research questions. For example, the corpus used for analysis for our SIGCSE 2020 and ACE 2020 papers, was from the data collected in spring 2019 as the data collected in fall 2019 was ongoing during article submission at the respective conferences. For the third paper (SIGCSE 2023), the corpus consisted of data from both spring and fall 2019. We further curated the corpus for the second paper to answer the research question: *What barriers do computing undergraduate students, who do not intern, encounter in securing an industry internship?* discarding data from students who participated in internships for the analysis. We will now describe the corpuses of each of the three papers.

Participants in the corpus for RQ1 and RQ2 reported in Paper 1 (who participates and preparation practices): 663 students responded to our survey by spring 2019 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=99.8%) and formed the corpus for our Paper 1. Of these 536 students, 485 were enrolled at Site A, 44 at Site B, and seven at Site C. The students comprised 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 21.1 years (SD=3.75, Min=17, Max=52). Other demographics are shown in Table 4-1 and Table 4-2.

Table 4-1. Academic standing and gender of participants (N=536) as reported in Kapoor & Gardner-McCune (SIGCSE 2020)

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 bachelors.
**Two students did not specify gender, and one student identified them as agender.

Table 4-2. Racial and ethnic identity of participants (N=536) as reported in Kapoor & Gardner-McCune (SIGCSE 2020)

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)

Participants in the corpus for RQ3 reported in Paper 2 (barriers to participation): From the corpus of the previous paper (N=536), 7 students were further discarded form 536 students due to lack of relevant responses from students that answered the RQ3 (*What barriers do computing undergraduate students, who do not intern, encounter in securing an industry internship?*). 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 which formed the corpus for this paper.

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 was an exchange student. The students comprised: 207 CS majors, 65 Computer Engineering (CE) majors, 10 Digital Arts and Sciences (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 4-3 and Table 4-4.

Table 4-3. Academic standing and gender identity of participants (N=302) as reported in Kapoor & Gardner-McCune (ACE 2020)

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 bachelors.
**One student did not specify gender, and one student identified them as agender.

Table 4-4. Racial and ethnic identity of participants (N=302) as reported in Kapoor & Gardner-McCune (ACE 2020)

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).

Participants in the corpus for RQ4 reported in Paper 3 (factors influencing participation): For this paper, data was used from students at Site A (University of Florida) which was collected in spring and fall 2019. Data from Site B and Site C was excluded as the survey deployed at those sites did not have identity measures to reduce the length of the survey. These identity metrics were introduced in the model for determining the relationship between internship participation and other factors.

698 students responded and consented to our survey at Site A after excluding 41 duplicates. The response rate was 43% (N=698, total course enrollment=1620). From this dataset, the following were discarded: students who were not pursuing CS-related majors or were CS minors (n=78), students who completed less than 80% of the survey (n=20), students who were not in our undergraduate program (n=15), students without gender classification (n=2), non-traditional students over age 24 (n=45), and students with a high proportion of relevant missing data (n=20).

Decisions to discard data were made for the following reasons: (1) we were trying to assess students' participation in internships who were enrolled in computing programs and represented traditional college students, (2) lack of data on a metric that was crucial for our analysis, and (3) inadequate representation of a certain population in our sample. Thus, our final corpus for Paper 3 consists of 518 students who were enrolled in CS (66%), CE (26%), DAS (4%) or double (4%) majors. The average age of the respondents was 20.2 (Min=18, Max=24, SD=1.4). Other demographics are shown in Table 4-5 and are representative of the student population in the CS program at respective institutions.

Table 4-5. Demographics of students in our corpus (N = 518) as reported in Wolf et al. (SIGCSE 2023)

Year					Gender		Race/Ethnicity				
1	2	3	4	5-6	M	F	White	Asian	Hispanic/Latinx	African American	Other
27%	18%	32%	17%	5%	73%	27%	47%	25%	20%	6%	3%

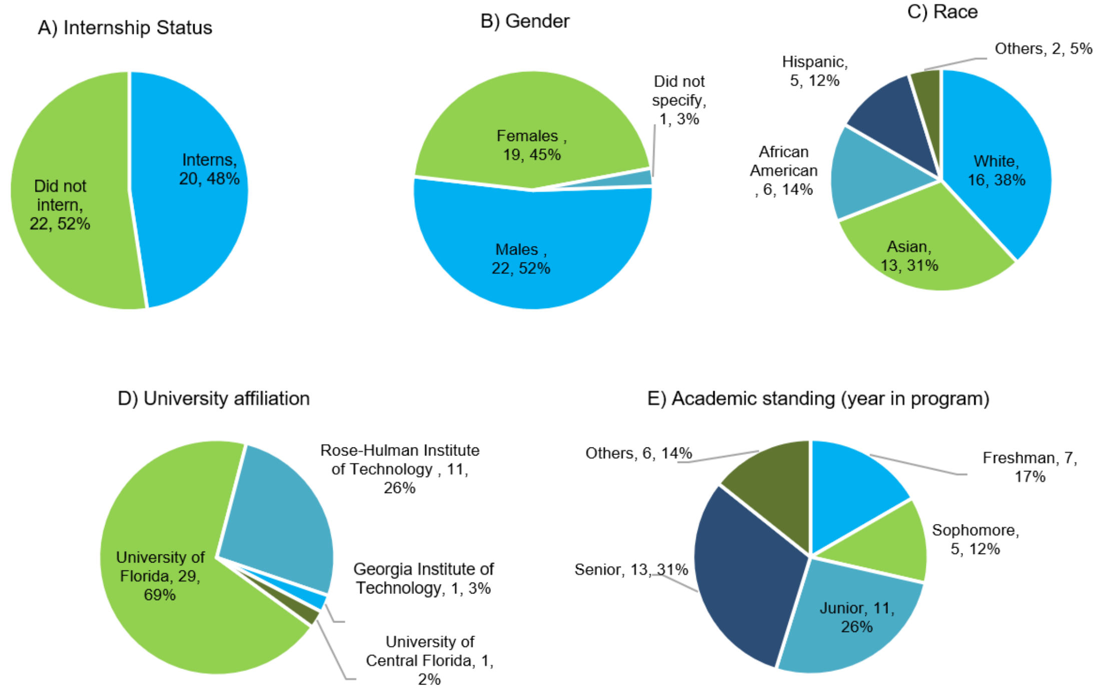


Figure 4-1. Demographics of interviewed students (N=42)

Participants in the corpus for interview analysis (differences between students who participate in internships and those who do not, RQ5): I conducted semi-structured interviews with 42 computing undergraduate students who were purposefully recruited from our survey. While we tried to recruit an even number of participants across each demographic (internship status, gender identity, racial identity, year in program, and university affiliation), certain recruited demographic distributions were uneven but rather representative of the student population at two institutions: University of Florida (n=29) and Rose-Hulman Institute of Technology (n=11). For instance, instead of an equal number of students from different racial backgrounds, we had twice as many Asian or White students compared to Hispanics or African Americans. We had one interviewee each from the Georgia Institute of Technology and the University of Central Florida (UCF). At the former institution, we failed to recruit interviewees although we proactively reached out to recruit a larger sample using their contact information in the survey. We recruited an interviewee at UCF based on a referral from another student who stated that the candidate had a rich story on how they received an internship and hence we were interested in capturing their experiences. UCF is a similar type of institution to the University of Florida, as both are large public universities. The number of students across each demographic attribute is shown in Figure 4-1.

4.3.5 Data Collection

We gained consent from the Institutional Review Board at Site A for a multi-institutional online survey administered over Qualtrics and semi-structured interviews.

4.3.5.1 Survey

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, 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. All questions were optional and were either developed from the findings of our pilot study [77, 78, 81] or were taken from the following three sources: NCWIT Student Experience of the Major Survey [118], and CRA Data Buddies Survey [179], and the revised version of Bennion and Adams' Extended Objective Measure of Ego

Identity Status (EOM-EIS) validated instrument [14] which consisted of measures to quantify Marcia's identity statuses [104]. The mapping of our research questions to the survey questions for the three papers is shown in Figure 4-2.

Paper	Research Question	Survey Section	Survey Metrics/Questions
Paper 1 (who participates and preparation practices)	RQ1. Who are the computing undergraduate students that participate in industry internships?	Demographics (5) Industry (1)	Year, Gender, Employment Status, Household income, Race/ethnicity, Internship Participation
	RQ2. How does the preparation process of computing undergraduate students who secure an internship differ from those who do not intern?	Demographics (1) Industry (2) Professional Development (2)	Internship Participation, GPA, Time on preparation, and practicing interview questions
			How did you prepare or how are you preparing to get an internship?
Paper 2 (barriers to participation)	RQ3. What barriers do computing undergraduate students, who do not intern, encounter in securing an industry internship?	Industry (1)	Why haven't you interned so far?
Paper 3 (factors influencing participation)	RQ4. What are the factors that influence undergraduate computing students' participation in internships?	Demographics (8) Identity (4) Professional Development (1) Industry (1)	Household income, Race/ethnicity, Gender, Age, Employment status, GPA, High school courses in CS, Year in school, Diffusion score, Foreclosure score, Moratorium score, Achievement score, External involvement score, Internship Participation

Quantitative Question (Multiple Choice) Qualitative Question (Open-ended)

Figure 4-2. Survey questions to answer our research questions for Study 2

Paper 1 (who participates and preparation practices). In this paper, we focused our analysis on 486 student responses on an open-ended question from the industry section and 536 student responses on nine multiple-select questions from the Demographics, Industry, and Professional Development sections. The open-ended question was "*How did you prepare or how are you preparing to get an internship?"* and the nine factors were gender, racial/ethnic identity, academic year, household income, employment status, participation in internship, participation in technical interviews, time devoted to career development, and GPA.

Paper 2 (barriers to participation). For this paper, we focused our analysis on 302 student responses on an open-ended question from the industry section and three factors from the demographics (gender and academic year) and industry sections (participation in an internship) 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.

Paper 3 (factors influencing participation). In this paper, we focused our analysis on 14 multiple-select questions from the Industry, Demographics, Professional Identity, and Professional Development sections. These survey question metrics and types are further described in Table 4-6. We selected these questions for the following reasons: (1) our approach to analysis is quantitative and hence we discarded open-ended questions, (2) the question was irrelevant for answering our research question, and (3) the question provided background information on the sample or context for replication. Our response (dependent) variable for this paper is a binary categorical variable representing participation in internship(s) or co-op(s) during a student's enrollment in a degree program (not counting internships during high school). We asked students if they had previously interned or were going to participate in an internship in the upcoming summer (they already received an offer). If the student answered yes to either of these choices, they were coded as "yes" as we are trying to understand students' ability to secure internships. We used 13 explanatory or independent variables (described in Table 4-6) in our model to identify their associations with a student's participation in an internship.

Table 4-6. Independent variable descriptions as reported in Wolf et al. (SIGCSE 2023)

Variable Category	Independent Variable	Description (Coded value)
Demographic and Socioeconomic Factors	Household income ★	{“Less than $20,000” (1), “$20,000 to $34,999” (2), “$35,000 to $49,999” (3), “50,000 to $74,999” (4), “$75,000 to $99,999” (5), “$100,000 to $149,000” (6), “Over $150,000” (7)}
	Race/ethnicity ▲	{White/Asian (0), Underrepresented: all other ethnic and racial representations (1)}
	Gender ▲	{Male (0), Female (1)}
	Age ■	Numerical (Range: 18-24)
	Employment status ▲	{Unemployed (0), Employed - working along with the degree program (1)}
Academic Profile	GPA ■	University-level grade point average on a 4.0 scale
	High school courses in CS ▲	{No (0), Yes (1)}
	Year in school ★	{Freshman (1), Sophomore (2), Junior (3), Senior (4), Super Senior (5)}
Identity	Diffusion score ⊙	Marcia identity status composite score (scale: 6-30): Low exploration, low commitment
	Foreclosure score ⊙	Marcia identity status composite score (scale: 6-30): Low exploration, high commitment
	Moratorium score ⊙	Marcia identity status composite score (scale: 6-30): High exploration, low commitment
	Achievement score ⊙	Marcia identity status composite score (scale: 6-30): High exploration, high commitment
External Involvement	External involvement score ⊙	Composite score based on involvement in 14 activities, e.g. hackathons, clubs, etc. (scale: 0-42)

Key: Binary encoded categorical ▲ | Ordinal encoded categorical ★ | Quantitative ■ | Quantitative variable computed from ordinal scale questions ⊙

Eight of our explanatory variables were single-item measures such as Gender or GPA. The remaining five variables consisted of multiple-item measures. These multiple-item measures were aggregated to form scores representing four identity status variables and one variable called *External Involvement* which denotes a composite score for a student’s involvement in activities outside the classroom such as research, hackathons, conferences, and student clubs, etc. For the *External Involvement* variable, we collected information on how frequently a student participated in activities outside the classroom using an ordinal scale for each activity (“Never {coded to 0}”, “Once {1}”, “2-3 times {2}” and “4 or more times {3}”). The composite score for each student was computed by aggregating the numerically coded responses of participation frequencies in all activities. For example, if a student stated that they participated in 2 of the 14 activities (e.g. personal projects and clubs), and they participated in each of them “Once” (coded as 1), their *External Involvement* score was 2 out of a maximum possible score of 42 (14 x 3).

Four MCQs in our survey that pertained to Marcia’s identity statuses measured using the EOM-EIS instrument consisted of multiple items for an *identity status* (six 5-point Likert statements per status, 24 statements in total). For measuring each status, the scale included two statements that gauged *identity status* in relation to occupation, recreational activities, and lifestyle [14]. Thus, each status had a corresponding variable representing the aggregate of six ordinally coded 5-point Likert statements (Strongly disagree: 1 to Strongly agree: 5) and had a range between 6 - 30. A higher value in a status scale implies a higher likelihood for a student to be in that status. We computed Cronbach’s alpha, a measure of internal consistency of a scale that measures a latent variable (in our case each *identity status* was a latent variable). Cronbach’s alpha measures how closely related a set of single-measure items are as a group. For our sample, Cronbach alpha coefficients were 0.64 for diffusion status, 0.83 for foreclosure, 0.61 for moratorium, and 0.62 for achieved status. While Cronbach alpha coefficient values of 0.70 or greater are an indicator of high reliability of an instrument in social sciences [153], Pallant argues that variables measured with less than 10 items generally have lower values of Cronbach’s alpha [123]. For each status, we used six statements, and hence the lower values of the coefficient could be attributed to the lower number of items in our scale. Moreover, the range of values for our Cronbach’s alpha coefficients was in line with the original EOM-EIS instrument [14] as well as subsequent studies that used this scale in other domains [95]. Hence, there is a possibility that scales for measuring complex identity statuses have lower internal consistency than other constructs.

4.3.5.2 Interviews

The semi-structured interview questions and script were designed based on our findings from our previous study (Chapter 3) and our research questions for this study. My advisor and I co-developed the interview script and resolved any discrepancies or conflicts through conversations until we reached a consensus. Each interview script was tailored for an interviewee to a limited extent after reviewing their respective response in the survey as well as a comprehensive review of their resume. I interviewed 42 students in 2019 who gave their consent. The students were compensated with a $20 gift card for their time and participation.

The average interview time was 55 minutes (Range: 21-74 minutes, SD: 10 minutes). The interview script consisted of seven sections with each section consisting of one to seven questions and follow ups which were asked to the interviewee based on their survey, resume, and interviewee’s response. These seven sections and sample questions are shown in Table 4-7. The interview audio was transcribed using a professional service and I reviewed each transcript to ensure they were accurate.

Table 4-7. Sample interview questions used in Study 2.

Section	Example Questions
Grand Question	Why did you decide to pursue a Computer Science or Computer Engineering degree?
Career goals and choices	You mentioned you want to become a _________, can you tell me how you got interested in ______?
Preparation for Career	How are you preparing yourself to become a _____ and work in ______?
Professional Experience (e.g. Internships)	Interned: You indicated on the survey, you participated in internships in ____ year, tell me the story of how you got your first internship? Not an intern (Applied but failed): Through prior research we found that only 40% of juniors/seniors pursue internships, why do you think you haven't *secured* an internship so far? Not an intern (Not applied due to lack of confidence, skills, etc.): Through prior research we found that only 40% of juniors/seniors pursue internships, why *haven't you applied* for an internship so far?
Professional Development (e.g. Personal Projects, Clubs, Hackathons, etc.)	You have participated in _____ clubs/hackathons/projects. Out of all these, which was most beneficial for your professional growth as a _______?
Degree Program Experience	How has your CS coursework shaped your professional interest and identity?
Hypothetical	What mistakes did you make during the degree program, which you would advise your junior/brother/sister not to make, if they were to enroll into a similar program in future?

4.3.6 Data Imputation and Preprocessing for Modeling Factors Associated with Internship Participation (RQ4)

Our final data corpus for Paper 3 (factors influencing participation) consisted of missing data as all questions in our survey were optional. Before feeding data into the model, we had to deal with missing data and multicollinearity. The total missing data for explanatory variables we imputed in this paper was 1.4% (n=326, N=23828 total data points). Given that the overall missing data was relatively low (1.4%) when compared with the number of responses that had some missing data point (40%), we decided to impute data rather than discard the incomplete responses. At a granular level, we imputed data (replaced missing values with substitute) for the following explanatory variables: GPA (n=19, N=518, 3.6%), age (n=43, N=518, 8.3%), household income (n=47, N=518, 9.1%), identity achievement (n=5, N=3108 single-item measures, 0.2%), identity diffusion (n=9, N=3108, 0.3%), identity foreclosure (n=5, N=3108, 0.2%), identity moratorium (n=12, N=3108, 0.4%), and external involvement score (n=186, N=7252, 2.6%). We used imputation techniques depending on the type of the missing data (i.e., quantitative or categorical) and the skewness of a variable's distribution. It is recommended to not replace missing values with the mean for skewed data distributions because outliers are more likely to influence the mean, therefore we utilized either the median or mode [3]. We used the seaborn python library to plot a kernel density estimate and histogram with bins. We observed that the GPA distribution and household income were skewed towards the left, the external involvement score and age were skewed right, and identity scores were all slightly skewed (see Figure 4-3). As such we imputed missing values for numerical explanatory variables such as GPA, age, or scores with the median values and used the mode for household income which is a categorical explanatory variable.

Multicollinearity. Before conducting regression analysis, we also explored the possibility of correlations between our explanatory variables to limit the possibility of introducing multicollinearity in our model. Multicollinearity can lead to higher variance, overfitting, and difficulty in model interpretation due to instability in the magnitude of regression coefficients [60]. If a regression model is composed of two or more predictors that are moderately or highly correlated, multicollinearity exists.

A B

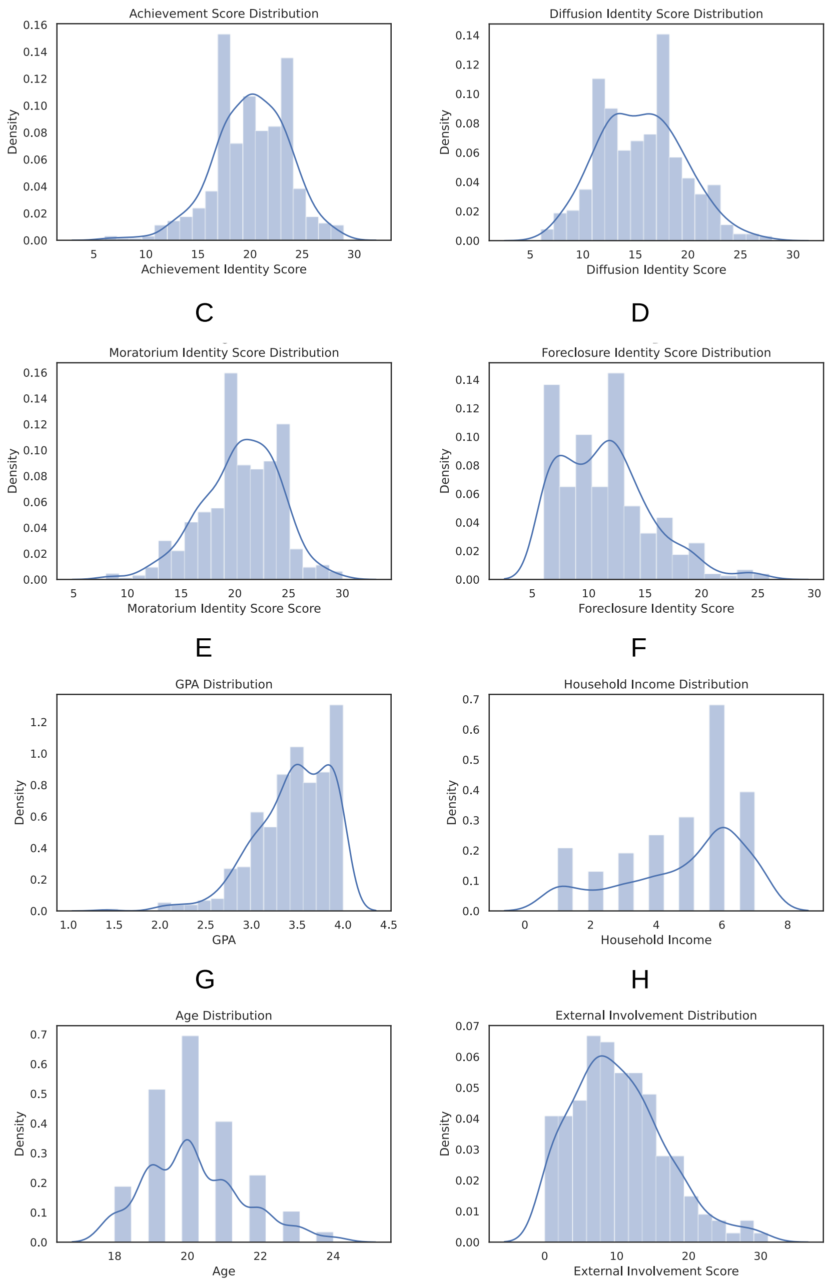


Figure 4-3. Distributions of imputed variables as reported in Wolf et al. (SIGCSE 2023): A) – D) Distributions of identity statuses. E) Distribution of GPA. F) Distribution of household income. G) Distribution of age. H) External involvement distribution.

A common method for checking if multicollinearity exists in a model is checking for high correlations among pairs of predictor values. In our study, we check for correlations among the predictors using Pearson's R for continuous vs. continuous cases, Correlation Ratio for categorical vs. continuous cases, and Cramer's V or Theil's U for categorical vs. categorical cases using code modified from the dython library which provides data analysis tools in python [180]. We consider correlation coefficients with a magnitude greater than ±0.7 to be highly correlated [116]. Also, we calculated the variance inflation factor (VIF) as an additional collinearity diagnostic metric [60]. A general rule is that if the VIF score for a predictor is greater than 5, it is recommended to remove one of the correlated explanatory variables to limit multicollinearity. The VIF values for predictors were below the threshold and ranged from 1.06 to 2.98. However, age was highly correlated with the year in school (Pearson's R = 0.80) and hence we excluded age as a predictor in our model.

4.3.7 Data Analysis

4.3.7.1 Quantitative bivariate analysis of survey data (RQ1 & RQ2)

We used descriptive and inferential statistics to answer RQ.1 (*Who are the computing undergraduate students that participate in industry internships?*) and RQ.2 (*How does the preparation process of computing undergraduate students who secure an internship differ from those who do not intern?*). The quantitative bivariate 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 an adequate representation for that level of the nominal variable. We used the following tests in our bivariate analysis:

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 [37].

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) [36, 60].

4.3.7.2 Quantitative multi-variate analysis of survey data (RQ4)

For RQ.4 (*What are the factors that influence undergraduate computing students' participation in internships?*), we used a binary logistic regression model to identify consequential factors for securing internships. This model can be used to understand the relationship between categorical (e.g., Gender) and continuous (e.g., GPA) explanatory variable(s) and a dichotomous categorical (internship participation: yes/no) response variable [60]. The logit (i.e., the natural logarithm of an odds ratio, a measure that defines the ratio of successes to failures for an event) forms the basis of logistic regression. The odds ratio provides a measure that represents the odds that an outcome will occur (e.g., a student participates in an internship), given the presence of some other factor and controlling for other predictors. For example, we can obtain an odds ratio of a student's participation in an internship given they took high school courses in CS. This measure helps us quantify the strength of the correlation between demographic, academic, and identity factors and a student's participation in an internship(s). The logistic regression equation takes the following form:

$$Z = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_{12} X_{12} \tag{4-1}$$

where, P_i is the probability of event i, β_0 is the constant coefficient, $X_1 \ldots X_{12}$ are the explanatory variables, and $\beta_1 \ldots \beta_{12}$ are coefficients of explanatory variables. A positive coefficient indicates a positive correlation between response variable and the coefficient's respective explanatory variable, and a negative coefficient indicates a negative correlation. For a logistic regression model, the null and alternative hypotheses are:

$$H_0 = \beta_1 = \beta_2 = \cdots = \beta_{12} = 0 \tag{4-2}$$

$$H_A = \beta_1 = \beta_2 = \cdots = \beta_{12} \neq 0 \tag{4-3}$$

In our model, we incorporate 12 explanatory variables after getting rid of one of the explanatory variables, age, due to multicollinearity (as described in Section 4.3.6). Therefore, our null hypothesis, $\boldsymbol{H_0}$ is: *None of the predictor variables in our model have a relationship with computing students' participation in internships*. The alternative hypothesis, $\boldsymbol{H_A}$ is *at least one of the predictor variables in our model significantly contributes to CS students' probability of participating in internships*. For our regression analysis, we treated ordinal explanatory variables (e.g., year in school) as continuous similar to other research in social sciences [141]. Our analysis including data cleaning and preprocessing was conducted in Microsoft Excel, IBM SPSS, and Python libraries such as pandas, matplotlib, seaborn, and researchpy [163].

4.3.7.3 Qualitative analysis of survey data (RQ2 & RQ3)

For RQ.2 (*How does the preparation process of computing undergraduate students who secure an internship differ from those who do not intern?*) and RQ.3 (*What barriers do computing undergraduate students, who do not intern, encounter in securing an industry internship?*), we analyzed open-ended student responses using thematic analysis based on an inductive approach [21] in Microsoft Excel. We started with the raw data and created codes inductively using words from participant responses. I coded the data into primary codes which were then clustered to form categories, and these categories were combined into themes. My advisor and I discussed the themes in which there was disagreement until a consensus was reached about the theme accuracy and reliability. The data was then recoded. This was followed by a frequency analysis of unique participant responses within each theme. I 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%.

4.3.7.4 Qualitative analysis of interview data (RQ5)

For answering RQ.5 (*How are computing undergraduate students who successfully secure internships different from those who have not interned*?), I identified the attributes and behaviors that distinguish students who successfully secure and participate in one or more internships from those who do not. I use data-backed descriptive personas to present this analysis. Personas in user centered design are personalized fictional characters that embody characteristics of a user type [96, 137]. These descriptive models provide insights into users' common goals, motivations, attitudes, and behaviors [40]. In my case, the user type is a *computing undergraduate* *student*, and the outcome of interest is *participation in an internship* (successful or unsuccessful). I used personas as an analytical tool as they have the ability to communicate compelling stories over abstract data [135] to a variety of stakeholders involved in the students' professional development process such as instructors, students, parents, higher education administrators, career development and industry professionals, etc. empathetically. Our personas are contextualized in student goals and learning trajectories and I use authentic quotes to back findings. In addition, the personas emphasize students':

- participation in the formal academic program,
- involvement in informal and non-formal learning activities,
- preparation process and strategies for securing internships,
- barriers encountered when securing internships,
- interaction with stakeholders that support career development.

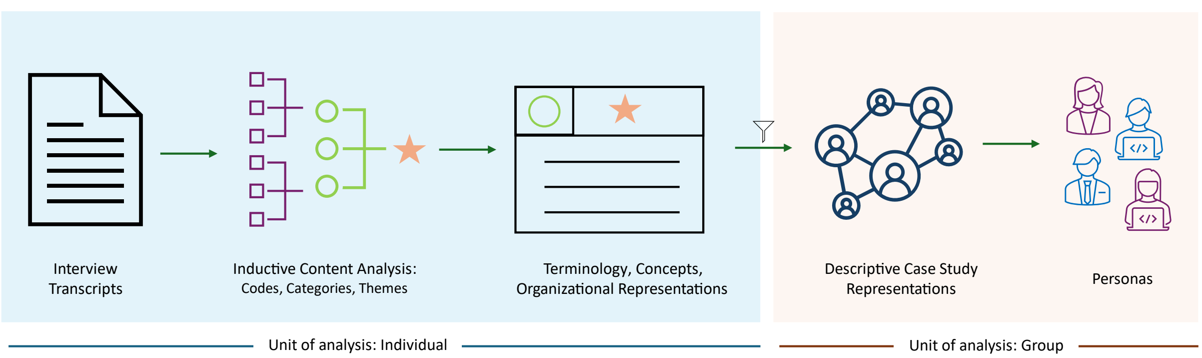


Figure 4-4. Data analysis process of generating personas

These personas can inform the community on student recommended resources for excelling professionally and provide insights on how higher education stakeholders can strengthen their degree program to improve employability of their students.

To develop these personas, I use interview data and triangulate the findings with students' data from the survey and resumes as needed. The interview data from 42 students was analyzed using multiple steps. First, I analyzed the student data with individuals as a unit of analysis and then shift to groups as a unit of analysis by creating themes that describe common characteristics of successful and unsuccessful students [42]. Figure 4-4 visually depicts the steps of the proposed analysis.

Unit of Analysis: Individuals. Before analyzing the interview transcript data, I used an analytic memo technique recommended by Miles et al. [112] to capture each interviewee's characteristics and reflect on emergent patterns and concepts I gained from reviewing interviewee's survey response, their resume, and my physical interview notes. Analytic memos involve writing reflective notes and making sketches signifying concepts, patterns, themes, and relationships during or after data analysis. Additionally, they improve the rigor and trustworthiness of my analysis process by providing a place to document my decision-making process by presenting my personal experiences, biases, and interpretation rationale [112, 143].

After writing a memo for a participant, I analyzed their interview transcript data using inductive content analysis [21] in Microsoft Excel. In this analysis, I developed primary codes that capture the semantic and latent essence of the interviewees' responses. The semantic codes capture interviewees' opinion based on face value or explicit answers while the latent codes focus on underlying meanings in data and look at the reasons for semantic content via interpretation [143]. The codes were clustered to form categories using the constant comparison technique as suggested by Corbin and Strauss [41], and these form the basis of my codebook. These categories were further abstracted into themes which capture tacit attributes and processes regarding students' participation in internships. This analysis technique continued until I reached theoretical saturation [41], meaning no new themes emerge from additional transcripts. These categories and themes provide an organizational structure that identifies the terminologies and concepts such as goals, attributes, behaviors, environments, and processes, etc. associated with students' participation in internships based on our data. Additionally, frequency analysis of the categories and themes was performed. To validate the themes, I discussed the theme and category descriptions and examples with my advisor and any discrepancies were fixed until a consensus was reached.

Unit of Analysis: Groups. In the next step, the unit of analysis shifted from individual to primarily two groups of students: *those who participated in internships* and *those who did not*. I identified the differences in these two groups and further created sub-groups representing ten cases which are presented as rich descriptive case studies [134]. The subgroups present cases beyond the dichotomy of successful vs unsuccessful students based on attributes and behaviors and were drawn from the emerging categories of my previous analysis at an individual level. These cases will support career development stakeholders to recognize distinct trajectories and introduce tailored interventions to solve the problems of practice rather than a one-size fit-all solution. An example of this categorization was

1. students who are applying for internships and failing to secure them
2. students who are interested in participating in internships but do not apply due to factors such as low self-efficacy or other socio-economic constraints
3. students who are not interested in participating in internships due to other goals

These case studies were further abstracted into visual persona representations that describe collective student goals, attributes, behaviors, and challenges related to career development for each case. The personas are used to highlight the problems of research and problems of practice with a variety of stakeholders such as instructors, career development professionals, higher education administrators, etc. so they can use them to design and introduce interventions.

4.3.8 Authors' Positionality

Regarding our positioning to internships, I pursued an internship during their CS graduate school and have worked for multiple years in the tech industry after graduation. Dr. Gardner-McCune pursued four internships during their undergraduate and graduate CS program. Both of us believe that pursuing internships have value in gaining employment and to secure an internship, one needs to take active steps outside of coursework. Our position might have influenced the qualitative coding process.

4.4 Findings/Results

4.4.1 Who Participates in Internships and Preparation Practices (RQ1 and RQ2 as Reported in Paper 1, Kapoor & Gardner-McCune (SIGCSE 2020))

In this section, we will answer our first two research questions of our study:

- **RQ1.** Who are the computing undergraduate students that participate in industry internships?
- **RQ2.** How does the preparation process of computing undergraduate students who secure an internship differ from those who do not intern?

Of the 536 students in our sample for Paper 1, 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 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 our 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.

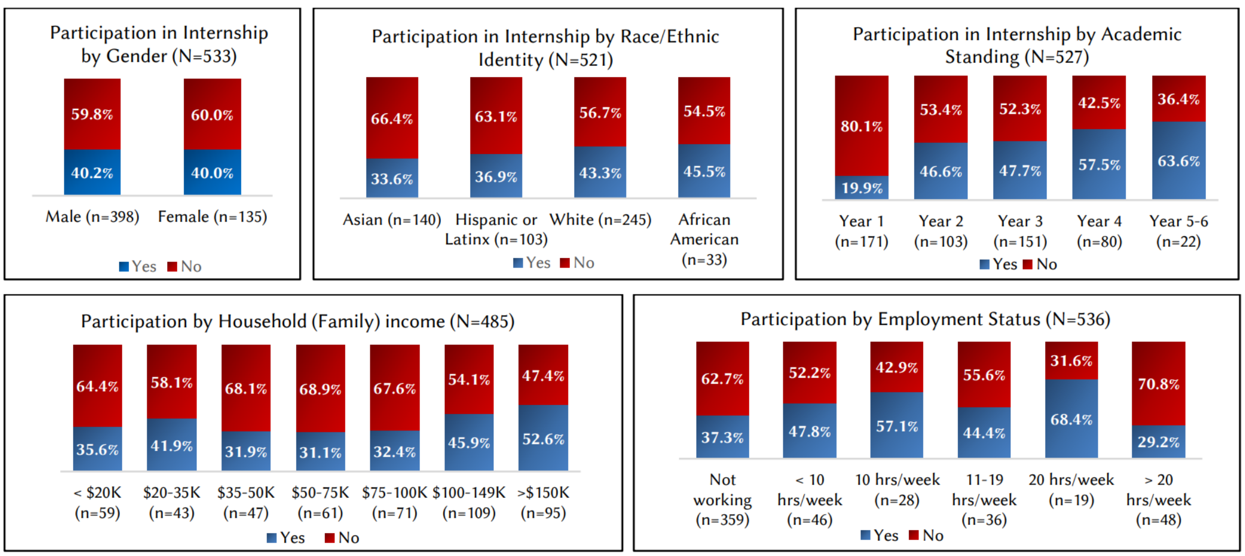


Figure 4-5. Demographics of students who participate and do not participate in internships as reported in Kapoor & Gardner-McCune (SIGCSE 2020)

4.4.1.1 Influence of demographics on participation in internships (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 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 (Figure 4-5) and tabular representation of the statistical results (Table 4-8 and Table 4-9).

Table 4-8. Chi-square tests for association between student participation in internship and demographics as reported in Kapoor & Gardner-McCune (SIGCSE 2020)

	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

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

Table 4-9. Mann Whitney U tests for relationship between student participation in internship and demographics as reported in Kapoor & Gardner-McCune (SIGCSE 2020)

	Statistical Significance		Effect Size
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

*** $p < 0.001$

We found that participation in an internship did not differ significantly by Gender (see Figure 4-5 and Table 4-8). Thus, we fail to reject the null hypothesis that participation in internships is not 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 (Table 4-8).**

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 [35]. **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 (Figure 4-5).** 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].

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. While we noticed that those who were not working or were working for more than 20 hours per week were less likely to participate in internships, **based on disaggregation of our dataset using Employment status, the results were not significant** when conducting the Mann Whitney U test.

To sum up, we found that higher household income and higher academic standing (e.g., junior or senior) positively correlated with internship participation. As a corollary, lower household income and lower academic standing (e.g., freshman or sophomore) were less likely to participate in internships. Additionally, participation in internships were not significantly associated with gender, employment status, and racial/ethnic identity.

4.4.1.2 Students' preparation process to secure internships (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 that describe the 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.

Theme 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 mentorship from seniors, family, university career centers, or peers who secured internships. For instance, Student P368, a senior female who had previously interned stated,

> Since freshman year, I have been very career-focused. I have attended career showcase & CDW [Career Development Workshop which is equivalent to a career fair where employers recruit candidates] 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.

Theme 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. For example, Student P239, a senior male who had interned suggested,

> I've been preparing since late 2017 by attending UFSIT [UF Student Infosec Team] club meetings, taking cybersecurity classes, participating in ethical hacking events.

Theme 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 [181], GeeksforGeeks [182], and HackerRank [183], developing interviewing skills, studying data structures and algorithms, and reading books of which "Cracking the Coding Interview" [106] 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. Student P426, a junior female who interned stated that,

> 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 where I am active and went to information sessions on campus to find opportunities.

Theme 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. For instance, Student P154, a sophomore male who had not interned before stated that he is making sure my grades are impressive and taking as much away (e.g. skills and knowledge) from my classes as possible [to prepare for the internship recruitment process].

Comparing the preparation process. When comparing the preparation process of interns and students who did not pursue internships, 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) - 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 ($z = -4.40$, $p < 0.001$, $\eta^2 = 0.04$). The effect size was 0.04, which is categorized as a small to medium effect by Cohen [37]. The second quantitative question, students' involvement in practicing technical interview questions was also 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 [37]. **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 4-6).**

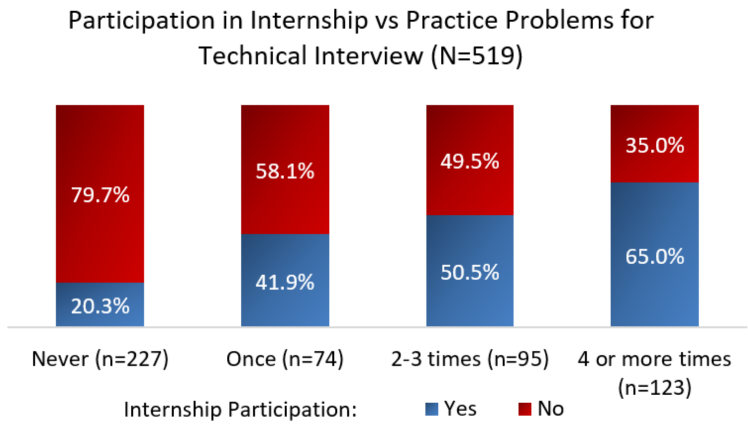


Figure 4-6. Relationship between practicing technical interview problems and internship participation as reported in Kapoor & Gardner-McCune (SIGCSE 2020)

For the *Status-quo* theme, we found more students who did not intern (28.7%) 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) indicating that academically the average GPA of an intern and a student who did not participate in an internship were similar. 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 the next subsection.

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 students' participation in internships, which means that students' mentioning that they were working on building skills was not correlated with their participation in an internship. In the future, it would be valuable to understand the nuances in skill building - such as what skills are acquired by students and from where? How much effort is exerted by students in skill acquisition? If skill building leads their identity status shift from exploration to commitment phases [104]?

4.4.2 Barriers to Participation (RQ3 as Reported in Paper 2, Kapoor & Gardner-McCune (ACE 2020))

Our second paper, Kapoor & Gardner-McCune (ACE 2020), focused on understanding why most students in our sample (59.9% of 533 students) are not participating in internships (RQ3. *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 4-10 and Figure 4-7).

Table 4-10. Themes for barriers to securing internships (N=302) as reported in Kapoor & Gardner-McCune (ACE 2020)

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%

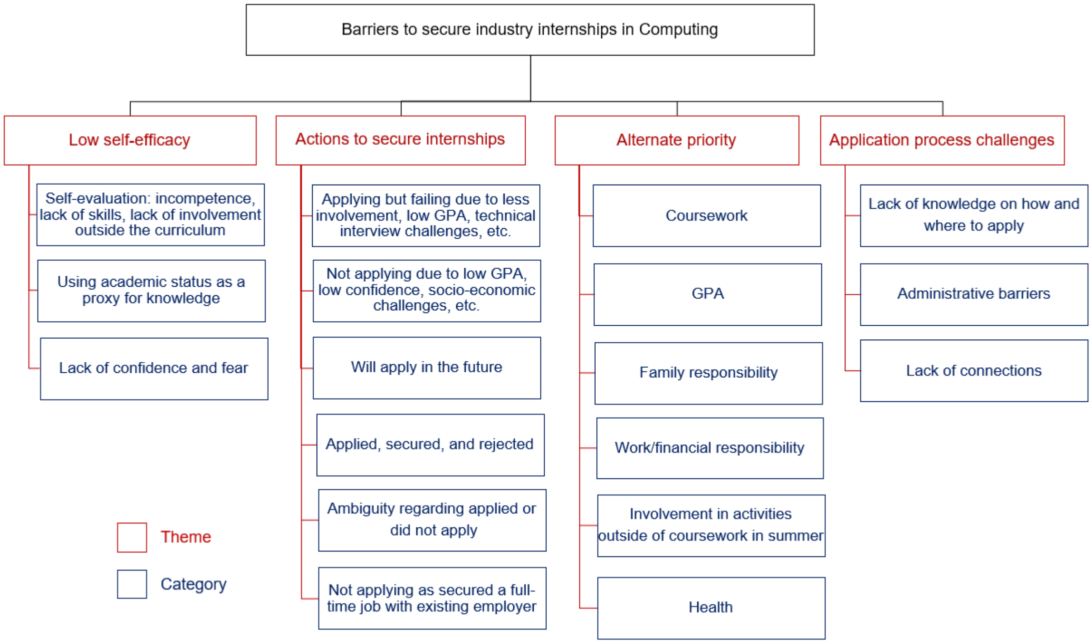


Figure 4-7. Thematic analysis of barriers to securing internships in computing as reported in Kapoor & Gardner-McCune (ACE 2020)

Theme 1: Low self-efficacy. In this theme, 49% 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 they were not applying or securing an internship because of their age or year the students were in their 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 a lack of confidence and fear category. Some representative quotes from students belonging to this theme and different categories on why they did not intern include (Note that participant quotes can belong to more than one theme):

Self-evaluation: lack of experience and skills (Category 1.1)

> 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 (Category 1.2)

> 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 (Category 1.3)

> I'm not sure how to begin finding an internship and I have a lot of anxiety and feel incompetent. - P327, Junior Female

> 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 (68% of 130, n=88), it is a cause of concern that a large number of sophomores (33% of 52, n=17), juniors (37% of 70, n=26), and seniors (29% of 34, n=10) who did not intern also had low self-efficacy.

Theme 2: Actions to secure internships. Within this theme, 37% 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, 42% 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 the 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% 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. Further, 16% of the 113 students (n=18) stated that they were working on building skills and will apply in the future and 12% 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% 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. 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 (Category 2.1)

Prominent 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 (Category 2.2)

Prominent 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 (Category 2.3)

> 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 (Category 2.4)

Prominent 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

Theme 3: Alternate priority. In this theme, 34% 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 the curriculum, planned to graduate early, or had a hard time managing 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 (Category 3.1 and 3.2)

> 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 (Category 3.3 and 3.4)

> 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, projects, etc.

(Category 3.5)

> 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 (Category 3.6)

> 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 (30% of 77 females, n=23) when compared to males (19% of 223 males, n=43), while males were more likely to manage responsibilities revolving around work or family with coursework (10% of 223 males, n=22) when compared to females (5% of 77 females, n=4).

Theme 4: Application process challenges. 5% 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 (Category 4.1)

> 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 (Category 4.2)

> 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 priorities including coursework, family/work/ financial responsibilities, or challenges related to the application process.

4.4.3 Factors Influencing Participation (RQ4 as Reported in Paper 3, Wolf et al. (SIGCSE 2023))

Our third paper, Wolf et al. (SIGCSE 2023) aimed to answer the following RQ4. *What are the factors that influence undergraduate computing students' participation in internships?* To answer this question, we analyzed data from 518 undergraduate students in computing majors enrolled at a single institution in the US. Trends in our explanatory variables and response variables are described in Tables 4-11, 4-12, and 4-13.

Table 4-11. Descriptive statistics of dependent/response variables as reported in Wolf et al. (SIGCSE 2023)

Variable (N=518)	Outcome	Count	%
Internship participation	No internship experience	301	58.1
	Participated in at least 1 internship	217	41.9

Table 4-12. Descriptive statistics of explanatory ordinal/numeric variables as reported in Wolf et al. (SIGCSE 2023)

Variable (N=518)	Mean	SD	SE	95% Conf. Interval	
GPA	3.45	0.42	0.02	3.42	3.49
Achievement score	20.09	3.58	0.16	19.78	20.40
Diffusion score	15.54	4.02	0.18	15.20	15.89
Foreclosure score	11.44	4.04	0.18	11.09	11.79
Moratorium score	20.53	3.65	0.16	20.22	20.85
Involvement score	10.25	6.51	0.29	9.69	10.81
Household income	4.82	1.89	0.08	4.66	4.98
Year in school	2.54	1.20	0.05	2.44	2.65

Table 4-13. Descriptive statistics of explanatory categorical variables as reported in Wolf et al. (SIGCSE 2023)

Variable (N=518)	Outcome	Count	Percent
Secondary CS Education (High school CS courses)	No	261	50.39
	Yes	257	49.61
Employment status	Unemployed	360	69.50
	Employed	158	30.50
Gender	Male	379	73.17
	Female	139	26.83
Race	White or Asian	374	72.20
	Underrepresented	144	27.80

Table 4-14. Regression results as reported in Wolf et al. (SIGCSE 2023)

	Coef. β	Std. Err	Z	p > |Z|	CI for Coef. β [0.025	0.975]	Odds Ratio exp(β)	CI for Odds Ratio 5%	95%
Const	-5.53	1.60	-3.45	0.00	-8.67	-2.39	0.00	0.00	0.09
HS CS Edu.	0.29	0.21	1.36	0.18	-0.13	0.71	1.34	0.88	2.04
Employment	0.10	0.23	0.45	0.65	-0.35	0.56	1.11	0.70	1.75
Year in School	0.57	0.10	5.72	0.00***	0.38	0.77	1.77	1.46	2.16
GPA	0.51	0.28	1.80	0.07	-0.05	1.06	1.66	0.96	2.89
Household Income	0.22	0.06	3.76	0.00***	0.11	0.34	1.25	1.11	1.40
Gender	–0.28	0.24	-1.16	0.25	-0.76	0.19	0.75	0.47	1.22
Race	0.16	0.24	0.67	0.50	-0.31	0.63	1.18	0.73	1.88
Moratorium Score	0.01	0.03	0.48	0.64	-0.04	0.07	1.01	0.96	1.07
Diffusion Score	-0.06	0.03	-2.14	0.03*	-0.12	-0.01	0.94	0.89	0.99
Achievement Score	0.01	0.03	0.29	0.77	-0.05	0.07	1.01	0.95	1.07
Foreclosure Score	-0.01	0.03	-0.34	0.74	-0.06	0.05	0.99	0.94	1.05
Involvement Score	0.12	0.02	6.79	0.00***	0.09	0.16	1.13	1.09	1.17

No. of Observations: 518	Pseudo R^2: 0.21	LLR p-value: 4.7e-25
Df Residuals: 505	Log-Likelihood: -279.5	* $p < 0.05$
Df Model: 12	LL-Null: -352.2	*** $p < 0.001$

Our regression results can be found in Table 4-14 and our model is significant ($p < 0.001$). In this table, Coef. β represents the regression coefficient which estimates the relationship between the individual factor and whether students have received an internship. Std. Err represents the standard error, which measures the precision of the estimate of the coefficient. Z represents the Z-value, which is a test statistic that measures the ratio between a coefficient and the standard error. The Z-value is used to calculate the p-value of a factor, which is represented by $p > |z|$. A p-value is used to determine if a factor is statistically significant ($p < 0.05$). The odds ratio is a measure of practical significance and is represented by $\exp(\beta)$. If the odds ratio is greater than 1, the event that a student participates in an internship is more likely to occur as the predictor value increases. The last two columns represent the confidence intervals, which show the range of values that the Odds Ratio could fall under with 95% confidence.

According to our regression results, ***year in school***, ***household income***, ***identity diffusion score*****, and *****external involvement score***** are significant and are influential in predicting whether students will participate in internships.** The odds ratio for the *year in school* indicates that for every one-year increase, a student is 1.77 times as likely to have participated in an internship, after controlling for other predictors. The odds ratio for *household income* indicates that for every one-unit increase (movement to the next socioeconomic status), a student is 1.25 times as likely to have participated in an internship (i.e., a one-unit increase in *household income* is associated with a 25% increase in the odds of a student participating in an internship). Similarly, the odds ratio for *external involvement* indicates that for every one unit increase in the external involvement score, a student is 1.13 times as likely to have participated in an internship. The odds ratio for *identity diffusion score* indicates that for every one unit increase in diffusion score, the odds of *not* securing an internship increases by a factor of 1.06 after controlling for other predictors [60].

Our model fit was evaluated using McFadden's pseudo-R^2 coefficient (ρ^2). **The pseudo-R^2 of 0.21 indicates an excellent model fit.** The values for pseudo-R^2 tend to be significantly lower than the standard R^2 and should not be interpreted by the same standards of fit as OLS regression. According to McFadden, "*values of .2 to .4 for ρ^2 represent an excellent fit*" [107].

4.4.4 Differences Between Students Who Participate in Internships and Those Who Do Not (Interview Data Analysis, RQ5)

Students who participated in internships or were unable to do so demonstrated diverse characteristics. In this section, I will first describe the salient student attributes, strategies students use, and the challenges they face exhaustively. Additionally, I will present the definitions of these characteristics and discuss how many students in each of the two sets of students (interns, n = 20 vs did not intern, n = 22) whom I interviewed exhibited each characteristic. Lastly, I will describe ten personas that I have developed representing prominent categories of students who participate in the internship seeking process and demonstrate similar traits for the two groups of students – those who secured internship(s) and those who did not participate in internships. These personas support us in answering RQ5. *How are computing undergraduate students who successfully secure internships different from those who have not interned?*

4.4.4.1 Attributes

This subsection examines the four salient attributes that I identified among students, distinguishing between those who participated in internships and those who did not. These attributes were derived from students' experiences in coursework, participation in external activities such as clubs, hackathons, and personal projects, as well as their engagement in the internship application process and related behaviors.

1a. Proactiveness and Agency: *High (n=23, intern: 16, did not intern: 7)*

Students who participated or were willing to participate in an internship in the future demonstrated high proactiveness, intentionality, capability to learn independently, and personal agency. They actively sought opportunities to build their skills, were comfortable with independently or collaboratively picking up skills outside of coursework and applied and prepared for internships. These students would often be actively involved in extracurricular activities such as clubs, hackathons, mentoring, and research to build technical and professional skills. 16 students who participated in internships demonstrated high proactiveness and agency while seven students who did not participate in internships exhibited this trait. For instance, P354, a female student in her senior year who pursued five technical internships during the program shared that for her second internship interview, which was for a program management role, she prepared for the interviews by asking industry professionals at her first internship to help with mock interviews.

> So halfway through that first internship, […] I would just reach out to software developers and particularly project managers, program managers at the [Big Five United States tech company: Alphabet, Amazon, Apple, Meta, and Microsoft] and ask them like, “Can you give me a mock interview?” And I did that so many times. They were the ones that really helped me figure out the science of answering PM questions or the science of answering technical questions. […] I don't think I would have passed my PM interviews had I not taken, no, genuinely had I not taken those mock interviews with those actual PMs and actual software engineers.

Another example is P351, a female student in her junior year who was a teaching assistant actively pursuing personal projects. She participated in two internships and stated,

> Over summer break, I gave myself a personal challenge of developing personal projects with the goal of keeping, like one designing from

> scratch, which is hard. I gave myself a task of every two weeks I had to design from scratch and I started building out my personal web portfolio, just to show what I could do with HTML and CSS and Angular and stuff. I think definitely personal projects are a must if you're going to be in coding. That's how you keep growing, just challenging yourself to learn something new. That was definitely fun. I started playing with bootstrap and I started doing WordPress sites and using different frameworks.

P900, a male in senior year who participated in two internships at two of the Big Five United States tech companies (*Alphabet, Amazon, Apple, Meta, and Microsoft*) was also proactive in pursuing personal projects, networking and explicitly practicing technical interview questions,

> P900: I feel what has been unique about me particularly is my proactivity. I feel that being proactive has really set me forward, and so I say that I haven't seen the same proactivity in other students.
>
> Aman: Can you give me an example of proactivity?
>
> P900: It's being willing to email, to reach out, talk to recruiters, go to CDW [career development workshop], practice for interviewing, going to interviews, so companies come to events or host events, going to those, it's talking to professors. Freshman year, I joined a mentorship group. That's how I met [professor who he worked with on research], and then got involved in her life. […] I think my uniqueness is being able to prioritize and see what I need to do, and being proactive to get it.

Another student, P600 a female student in senior year who secured an internship but couldn't pursue it due to financial and family obligations demonstrated high proactiveness and agency by pursuing cybersecurity research and some personal projects,

> I have my professional Twitter account where I follow a bunch of different blogs. There's like, Dark Reading is one of them, I can pretty much pull it up now. There's like the TrustedSec Blog, and TrustedSec. There's Dark Reading, there's Occupy the Web, Malware Tech. I'll also follow the big names just like AWS Support because there is a huge DDoS of AWS a couple of weeks ago or like a month ago now. And then like US Cert of course, just to see what the government is wanting to publish. Schneier Blog as well. […] I have a virtual machine [for Linux], it's the virtual box. I use it to just like mess around with my own network. I should say also,

> another bunch of resources that I use to hone my skills is right after I graduated, I started studying immediately for my CompTIA Security Plus certification. And I was using resources from Mike Myers, Jason Deon, and there's this big book that I have here called Get Certified Get Ahead, it's by Darryl Gibson. And it's a really in depth book on like how to and also the Jason Deon practice test, and then, oh, Professor Messer. He has a lot of videos just going through all of the security plus objectives in depth. Some of them will also have how to videos, just going through the Kali Linux apps and doing fun stuff.

Students in freshmen and sophomore years who did not apply or participate in internships but were planning to apply for internships in the future also demonstrated high agency and proactiveness. For example, P692, a female in her freshman year who had not interned yet, but she was involved in clubs, hackathons and was actively networking and applying at career fairs. She demonstrated high agency and was applying for internships related to her interests in cybersecurity and data analytics,

> Basically, I'm interested in firewalls in cybersecurity. I applied to a couple different companies that sell different firewalls and have different measures that improve security for users and companies. Then as far as data analytics, I've applied to other companies that are data analytic companies, one of them I applied to is company based, so it gives the companies a product that they have created so that companies can track their users and their consumers, keep up with how their products are being sold to the different users. Both of them are, that one's kind of related to helping a company know its consumer base better, if that makes sense.

Another student, Y84 a female in freshman year who has not participated in an internship but demonstrated agency when applying for positions and when getting involved in clubs,

> This coming Wednesday, we have a career fair at Rose-Hulman and Rose-Hulman has preparing their freshmen. They said not to get discouraged. It's more about learning how to approach these businesses and asking them even if you don't want a freshman because a lot of them want upperclassmen, “What can I do so that next year when I come back, you will see me as a potential candidate?” That's how I've been preparing. I've also been uploading my resume on Handshake, which is what we use to find internships. I've been looking at that.

Y84 shared that her university's career center played a huge role in making her aware of the importance of career fairs and professional development,

> Our Student Career Services had two sessions. It was mandatory for freshmen to go, so we went into an auditorium and they sat us down the first day and talked to us about just starting your resume, the importance of starting a resume and actually they said like, "You should go to the Career Services before your sophomore year begins," so sometime in your freshman year and then the second session they made it more specific. They said how to write a resume when we go to the career fair, how to approach the businesses, how to talk to them. They said that we shouldn't be discouraged and they were telling us about... They showed us videos of previous alumni of Rose-Hulman. They talked about how when they were freshmen they didn't get internships, but they still went to career fair and they learned things from it other than getting a job.

1b. Proactiveness and Agency: *Low (n=2, intern: 0, did not intern: 2)*

In contrast, students in junior or senior years who did not participate in internships exhibited lower levels of agency or proactiveness, often due to lack of confidence and focus on alternative responsibilities of coursework, part-time jobs or family. Such students would often hesitate to participate in activities outside of coursework such as clubs or hackathons due to lack of confidence or would apply for jobs when they were presented with one from a mentor or list-servs rather than actively seeking positions. Two students who did not participate in internships exhibited this attribute. For example, P412 a male student in his super-senior year who was involved in courses and did not participate in an internship. He applied late for internships and couldn't clear technical interviews. He had low involvement in external activities and demonstrated low agency in activities he was involved in such as the hackathon he participated in,

> So I've been to only one hackathon and that was in 2017. That was actually me and the CEO [roommate] I mentioned and the other guy that worked on the website. We all went to this one together and this is kind of where we tried to sketch out the website and wire frame forms. I try to just

> create or sketch out how it looked like in different pages and stuff. We didn't really participate in any of the activities there. We kind of just walked around because it was our first time we've been to one, so we kind of just walked around.

Compare him to P440, a male student in junior year who demonstrated his proactiveness by participating in eight hackathons where he learned several technical concepts ad-hoc independently or with guidance from random teammates,

> As I got into University of Florida, I started going to all of the hackathons because I was like, "I've learned all about data structures and algorithms. I've done CS1, CS2, so I have all the fundamental knowledge, and now let me just go out there and learn".

2a. Resilience: *High (n=11, intern: 10, did not intern: 1)*

Students who participated or were willing to participate in an internship in the future demonstrated high resilience in the application process, coursework, or other activities in which they were involved with. They failed a lot often for multiple years when applying for internships or clearing technical interviews but continued to exhibit agency in applying after such failures. 11 students who participated in internships demonstrated high resilience while one student who did not participate in internships exhibited this trait. For instance, P679, a male student in super-senior year who secured an internship as a test engineer at a defense contractor shared that he "*applied from sophomore year to my senior year*" and during his senior year he failed an internship interview with SpaceX,

> So, SpaceX isn't the best about getting back to you, but they did give me some feedback, though. For them, it was just other candidates had more experience at that time. I **wasn't deterred**, just every interview, whether or not you get turned down, is good experience, because it teaches you how to interview better the next time. Each time you get interviewed, you learn what to say and what not to say, and you become more confident, because a lot of the time the first time people get interviews, they're very shy, or they don't quite know how to respond correctly, with the certain

> amount of confidence, because it's very important not to have too much confidence, but it's also important to have a little bit. Just the right amount.

P329, a male student in his senior year of study, demonstrated resilience after initially failing to secure a position and subsequently participating in three internships,

> I applied to a lot of companies [at SHPE]. [Regarding career fair at UF], Yeah, I attended every year, my, those first two years, I did not hear back from.

Similarly, P645, a female in her super senior year who secured two internships through technical conferences was resilient to continue seeking internships after her failure to secure one at the first conference in freshman year,

> I learned everything through trial and error. So, I went through the first couple of conferences, I didn't get anything, but I still had a good time as practice talking to professionals. So you're not always going to get it on the first try. That's what I would say.

On the contrary, a student who did not participate in internship, also demonstrated high resilience. P710, a female in her junior year who was looking for an internship in UX design demonstrated resilience when participating in hackathons. She didn’t get much out of her first hackathon. However, unlike some students who gave up participating in hackathons due to lack of confidence, she continued,

> The first few years I was really scared of trying to make a project. So, I feel like I didn't learn as much versus this one time I went to Georgia, I did apply myself and I learned so much from it.

2b. Resilience: *Low (n=1, intern: 0, did not intern: 1)*

One student who did not participate in an internship demonstrated low resilience and gave up applying after failing to secure an interview. Y82, a male student in freshman year who was planning to apply for internships in the future years applied to one company in the freshman year and stopped applying after receiving an email that he was not selected,

> I wasn't confident enough to apply to any internships, but I did in fact apply to I think one internship, and then after that I didn't get in, so I didn't apply after that thinking I don't have the experience or don't have the knowledge to secure an internship.

3a. Self-regulation: *High (n=13, intern: 9, did not intern: 4)*

Students in this category described that they were able to regulate their behavior when approaching the internship seeking process, external involvement activities or coursework. The students regulated their behaviors by strategically setting up goals, planning in advance, managing time between coursework and other activities, and staying organized. Nine students who participated in internships demonstrated self-regulating behavior while four students who did not participate in internships exhibited these behaviors. For instance, P440, a male student in junior year, who secured two internships shared that he tracked all his internship applications and the questions that he practiced for technical interviews as well as carefully managed his time for preparation,

> I think I had at least 80 to 90 [internship] applications that I'd sent out. And I was obviously keeping track of them in another Excel spreadsheet. […] The other thing is I've tried to manage my time really effectively. When I started off, I tried to manage proper sleep schedules for myself, and also day to day schedules. So I realized having long term goals was really good but having really short term goals and keeping myself accountable for achieving some things in a short span of time was also really important to me. So I made sure to have not daily goals, but weekly goals for myself. So by the end of the week, I should be done with this. If there's not, then I'm going to have to sacrifice going out or meeting my family. I'm just going to have to grind this out so that I achieve my weekly goal.

Similarly, P679, a male student in super-senior year who secured an internship as a test engineer at a defense contractor for the following summer shared,

> So, the past couple of years, if [courses have] taught me anything, it's how to be very, very organized, and have good time management. So, I use a calendar, I use schedules. The first thing I do in the morning to see what I have to do for the day. I typically do things in chunks of a week, so I'll write out what needs to be done this week, and what days I need to have it done by. That really just helps me keep organized, and I have developed a work ethic where I just work pretty much all day, and I'm used to it by this point. If I'm not working, I just feel almost lazy and lethargic, and I just want to get some work done. So, it's also a good thing having the amount of work, because it teaches you how to work hard, and if you enjoy working hard, it really shows.

Another student, P351, a female student in junior year who participated in two internships stated,

> Over summer break, I gave myself a personal challenge of developing personal projects with the goal of designing one from scratch. I gave myself a task of every two weeks I had to design from scratch and I started building out my personal web portfolio, just to show what I could do with HTML and CSS and Angular. I think definitely personal projects are a must if you're going to be coding. That's how you keep growing, just challenging yourself to learn something new. That was definitely fun. I started playing with bootstrap and I started doing WordPress sites and using different frameworks.

Two students also described that they were able to regulate their behaviors after they couldn't clear technical interviews. An example of such a student was P412, a male in his super-senior year who couldn't secure an internship but was able to secure a full-time job by regulating himself,

> So last year, I had a Facebook interview [for an internship], and I didn't make it past the first round. But that's kind of what motivated me to get the book and keep practicing. So I did those practice questions. Then this year, I've been in touch with or trying to contact a lot of recruiters and applied a lot of companies. Then one of the companies, VMware, actually reached out to me. Then they liked me, so I went through the whole process and then they ended up reaching out for an offer for a full stack development position.

He described his approach of how he prepared for interviews over the summer,

> Over the summer, I used the cracking the coding interview book. I was just going through practice questions, trying to practice for the interviews. I

> would go through the chapters - First I read an introduction, [that provides an] overview of creating algorithms and getting ready for the interview. Then it starts with the practice problems. So for those, I would first read the question and then because the lady that wrote the book also provides these steps of how to solve a problem, meaning that I don't just read the problem and start coding. So her steps were read the problem, gather all of the information, go through an example, and then write an algorithm on paper, no coding, just algorithm steps and then optimized algorithm. Then test it, and then once it's good, then convert it to code. So I would try to do that all on paper. I would do those steps, write the algorithm and then try to improve it. So once I wrote it on paper, I would then write it on the computer and then test it and then see if it worked or not. If it didn't work, then I would fix it. If I couldn't find a solution, then I would look for an answer online and try to see what I was doing wrong. Since the semester started, I kind of haven't spent much time on that, but I probably finished about 20 to 30.

On the other hand, students who did not intern but were building skills to intern in the future also exhibited high self-regulation skills. Some of these students demonstrated self-regulation skills for coursework rather than the internship recruitment process. P692, a female in her freshman year who did not intern yet but was actively building skills to intern in the future described,

> I'm a very planner oriented person, organizational person. Coming into college I planned it out, a four-year plan for courses I had to take. Each semester I do go and talk to my counselor about the courses that I'm proposed to take next semester, just to figure out if it's a good fit and if the courses work well together. […] Basically, I've never really been a procrastinator, I normally get things done. I normally create to do lists and prioritize things that actually have to get done. When I prioritize these, I also think about the commitments I've made to certain clubs. […] I prioritize it by finding a balance of schoolwork versus not schoolwork, where you feel as though you are using your talents in many different ways and many different outputs of life.

Similarly, Y82, a male student in freshman year who was planning to apply for internships in the future years shared his strategic approach to secure an internship,

> I'm starting right now for preparing for an internship. The way I'm doing it is I'm going in with the mindset that I'm not expecting to get any internship this year, but next year, and the next-next year, I will secure an internship. The way I'm planning on doing it is that I'm planning on getting all my

knowledge and all my resources and everything done this year and make sure I can network to many people so I can reach out and see, “Oh, hey,” and then go next year, after the next year, be like, “Oh, hey. Do you remember me from last year?” and then show an interest in the company. [That way I have] more chances of at least getting a phone call in the first place and then interviewing will be much easier because now I know the knowledge freshman year.

3b. Self-regulation: *Low (n=7, intern: 2, did not intern: 5)*

Students in this category were not able to regulate their behavior and would procrastinate often when approaching the internship seeking process, external involvement activities or coursework or forget to apply for internships. They described them as lazy or forgot to apply or prepare for internship applications or interviews. Two students who participated in internships demonstrated low self-regulation skills while five students who did not participate in internships exhibited this attribute. For instance, P382 a female student in her super-senior year who did not secure an internship as she was a transfer student and had low GPA stated,

When I was doing the degree program, I was playing games and stuff, and it was distracting, because these games required you to be on at a certain times of the day. So it took away the time I needed to focus on my career, and learn about things that I should be learning about.

P223 a male student in sophomore year who did not intern described that they forgot to apply for in,

Aman: A lot of tech companies like Microsoft, Google, Facebook, etc. run programs dedicated to internships for freshman and sophomores. Have you heard about those?

P223: Yeah, I did. I heard about that last year. Unfortunately, I did not remember to apply.

P401 a female student in her super-senior year secured an internship in her final year as she applied very late and had a low GPA. She described that she did not apply online to company websites and applied only to jobs through the university's career portal as filling out the applications was a lot of work,

> I mostly stuck with [applying at career center] because other places require you to basically rewrite your resume, but into small boxes. That takes a lot of work, so I've just been stuck to [career center application].

Students who interned also alluded low self-regulation skills. P401, a female student in her super-senior year who secured an internship due to her previous experience with graphic design in her final year stated that her biggest challenges were,

> Time management and self-motivation. If I don't have people depending on me to complete a task, I may most likely not be able to complete a set goal that I've set myself.

Similarly, P665, a male student in senior year who interned stated that he secured an internship quite late as he was lazy, unaware of the expectations, and not confident,

> I would say my own laziness and my own intimidation to do projects and join teams, that definitely got in the way of me getting more internships. And just kind of not knowing things I wish I knew back a few years ago. […] I didn't do enough [Leetcode questions], if I'm being honest.

4a. Ambition: *High (n=5, intern: 4, did not intern: 1)*

Students in this category described themselves as ambitious in terms of how they approached the process of securing internships often seeking many offers or evaluating multiple companies. Four students who participated in internships were ambitious while one student who did not participate in internships exhibited this trait. For instance, P440, a male student in junior year who secured two internships secured his first internship at a financial institution but had an aspiration to work for a large tech company. He was ambitious and did not settle for the same company although he had a return offer.

One student, P692 a female in her freshman year, who did not intern but was in the process of applying for internships was ambitious suggesting that she "*applied to pretty much any position that [she] felt [she] was interested in, […] in the hopes that when [she] get offers, [she will] have many different options to choose from*".

4b. Ambition: *Low (n=4, intern: 0, did not intern: 4)*

Four students who did not intern, also described a lack of ambition or were complacent with their part-time job or a fallback job when they were trying to pursue job recruitment. For instance, P591 a male student in the sophomore year who had a part-time job in taekwondo school and had applied to a few internships but failed stated,

> P591: I've applied to a couple [of internships]. I just think it's very competitive or maybe the ones I've been applying to have just been very competitive. Sometimes, I think that the fact I am interested in something else like Taekwondo will set me aside from other people, but I know that it also hinders me because I don't have as much technical skills as other do. I know they've put the time into that, so that's why I feel I haven't been able to secure one. Because I haven't been fully committed to developing my technical skills. […]
>
> Aman: Do you think, since you are pretty proficient at Taekwondo, this is hindering you from putting all your energy into developing tech skills? Like you have a safe space in the back of your mind.
>
> P591: Yeah. I think, yeah.

P591 was interested in becoming a taekwondo instructor after graduation along with a job in cybersecurity. Similarly, P315, a male student in senior year did not secure an internship as he was a transfer student and had low confidence. He hoped that the degree program allowed him to get a job as he is *"not that ambitious"* and that was what he needed.

4.4.4.2 Key findings from attributes

Students who participated in internships tended to exhibit higher proactiveness, a greater sense of agency, resilience in the face of setbacks, stronger self-regulation skills, and ambitious career aspirations. Conversely, students who did not participate in internships were generally associated with lower levels of agency, reduced proactiveness, less self-regulated behavior and were prone to complacency in cases.

4.4.4.3 Strategies

Students described 14 strategies that they followed pertaining to career preparation or internship/job seeking. These strategies were further abstracted into three themes (see Figure 4-8 and Table 4-15): (1) strategies specific to the application phase, (2) strategies specific to clearing interviews, and (3) generic strategies.

Theme 1. Strategies specific to the application phase (getting an interview)

These strategies pertained to a student securing an interview. We found eight categories in this theme. We further bifurcated this data based on student participation in an internship (see Figure 4-9).

1. Skill-building and involvement for boosting resume (n=18, intern: 9, did not intern: 9)

Eighteen students stated that they were building their resume by gaining skills through external involvement as sought by prospective employers in order to secure an internship. Students gained these technical and professional skills through participation in hackathons, research, student organizations, personal projects, leadership positions in clubs, etc. These technical skills included agile software development, mobile app development, web frameworks or libraries such as React and Angular, test-driven development, Virtual Reality and Internet of Things related projects, etc.

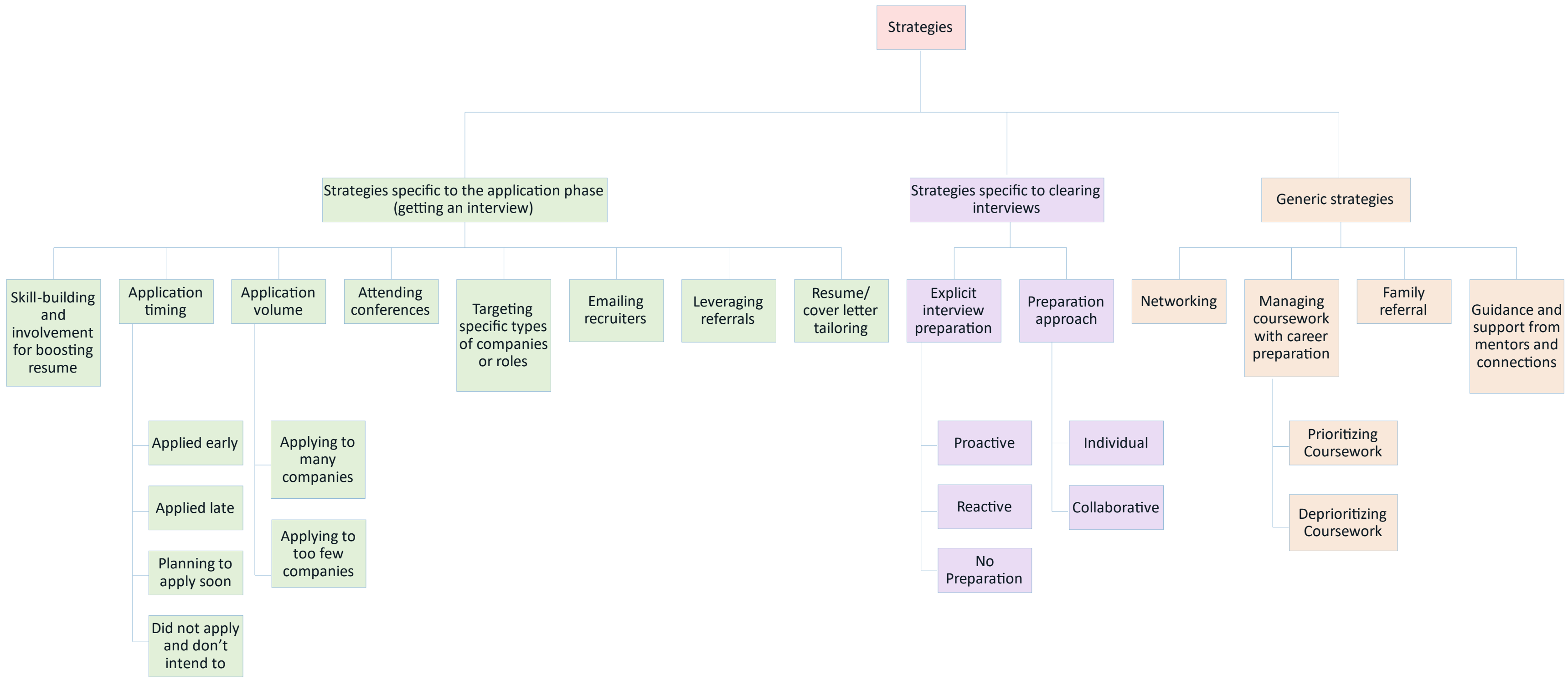


Figure 4-8. Strategies students followed pertaining to career preparation or internship/job seeking

Table 4-15. Strategies students followed pertaining to career preparation or internship/job seeking

Theme	Category	Sub-category	intern	did not intern
Strategies specific to the application phase (getting an interview)	Skill-building and involvement for boosting resume	Skill-building and involvement for boosting resume	9	9
	Application timing	Applied early	14	4
		Applied late	1	6
		Planning to apply soon	0	4
		Did not apply and don't intend to	0	2
	Application volume	Applying to many companies	9	2
		Applying to too few companies	5	9
	Attending conferences		6	0
	Targeting specific types of companies or roles		3	3
	Emailing recruiters		4	0
	Leveraging referrals		2	0
	Resume/cover letter tailoring		2	0
Strategies specific to clearing interviews	Explicit interview preparation	Proactive	12	3
		Reactive	0	7
		No preparation	3	7
	Preparation approach	Individual	12	10
		Collaborative	5	3
Generic strategies	Guidance and support from mentors and connections		10	9
	Managing coursework with career preparation	Deprioritizing Coursework	4	0
		Prioritizing Coursework	1	10
	Networking		12	5
	Family referral		3	1

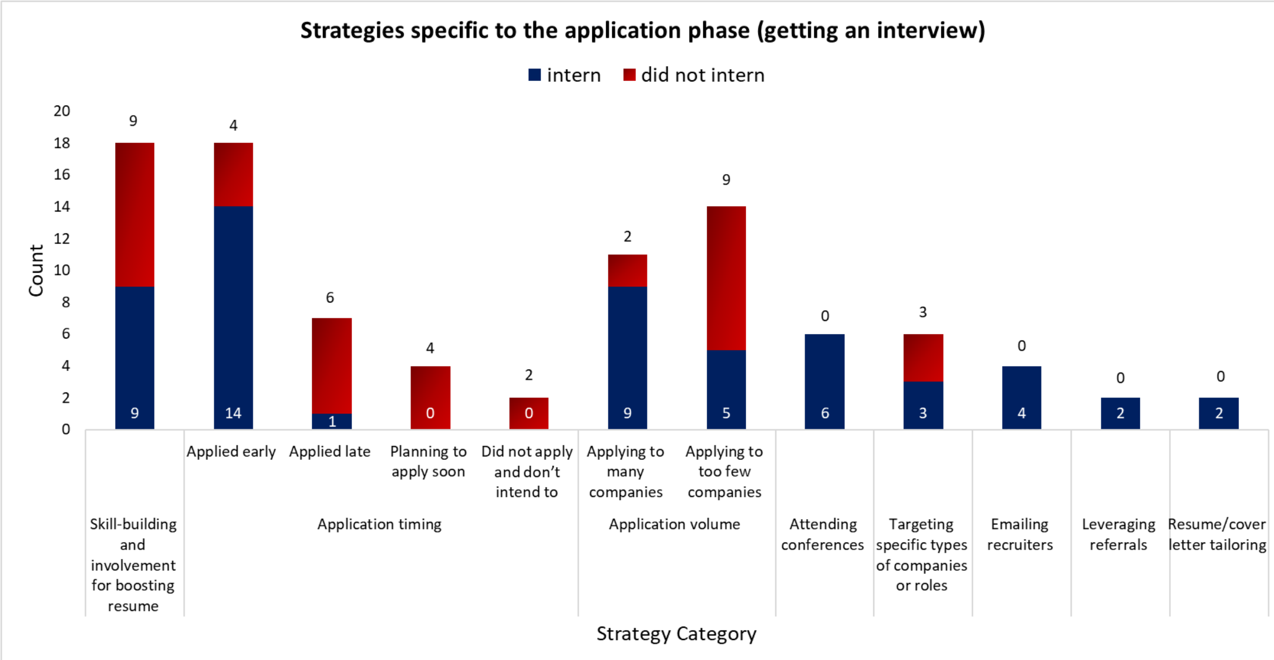


Figure 4-9. Strategies students followed specific to the application phase (getting an interview)

Nine of these 18 students pursued internships and the other nine did not intern. The latter students typically were building skills to show recruiters their involvement for future positions. For instance, P152, a female student in her junior year in the online CS program secured two internships. To prepare for securing internships, she stated that she was, "*working on [her] own personal projects to augment [her] resume*". Similarly, P665, who is a male student in his senior year and participated in an internship stated,

> I had research on my resume as I was interviewing that semester, and they liked it a lot. Recruiters like seeing that.

P679 is a male student in super-senior year was involved in clubs and personal projects. He secured an internship as a test engineer at a defense contractor, and he was actively building skills outside of coursework to show employers,

> I'm involved in an organization called Gatorloop, and we develop a prototype pod for the Hyperloop competition, put on by SpaceX every year. So, what we do with that is it's a two step process. One is the design, and we submit the designs and proposals, and then once we get

> approved we would start building. So, a lot of my time in that had been designing different systems, collaborating with different students and engineers on how to build the best design. That's been a big part of my experience. I've been a part of that for three or four years, and I feel really helped me grow, as an engineer, and then also, I guess, grow my network, and teach me how to be more social with professionals, rather than shy away from trying to be the one to initiate conversations.
>
> Then, I also do personal projects on the side. I've done some small IOT projects, and I've used Arduinos, and Raspberry Pi's, and things that on my own, just teaching myself. A lot of things that I do, too, is I'll just watch tutorials, and teach myself how to use different softwares. Not necessarily because I'll ever need to use them, but if I did need to use them, it would be good to know. Then it's also, for me, something I can put on my resume to show employers that if I'm dedicated to a task, I'll learn it. So, I've taught myself 3-D printing programs, and teaching myself Python currently, right now at home.

P578, a female student in her freshman year who is a double major in computer engineering and psychology, was not looking for internships as she felt it was too early for her, but she was proactively building her portfolio by getting involved in clubs and research opportunities,

> I got an email talking about the professor I'm doing research under and I always thought it'd be cool to do research as an undergrad, and also it looks good on my resume.

Similarly, P223, a male student in sophomore year who wanted to become a software developer in industry and specialize in computer graphics, was involved in a research lab, several clubs such as GatorVR, ACM club, Open-source club, etc., personal projects, and a hackathon. He did not intern during his undergraduate program but was actively building skills through his involvement in external activities in order to secure an internship in the future,

> I'm really trying to develop project management and interpersonal skills through my clubs so that I can show that I do have the kind of work ethic to get into larger scale projects at internships.

Another student, P591, a male in their sophomore year was involved in clubs, hackathons and personal projects. He found it hard to get an internship as he was not aware of positions in cybersecurity for internships and had applied to a few internships but failed. He was however working on personal projects which he stated were sought by employers,

> I think [personal projects] just shows these companies that you're not only learning these things in class, but you're applying them outside the classroom. That you have a genuine interest in it. I guess they like to see that.

P341, a female student in her senior year who did not secure an internship had a similar sentiment for personal projects,

> So, in the summer, since I had no classes for the first time, I took my time to make or to go into separate projects, multiple projects - some solo, some with my brother. So, I had to add that in my resume, and that showed my activities in the place of lacking internships. Having multiple activities seemed to get a lot of attention. That was basically my talk with all those interviews [which she subsequently participated in for full-time jobs], too.

Some students like P382, who is a female in her super-senior year who did not intern, was made aware of the importance of these external involvement activities by recruiters and she actively started pursuing online courses after this advice,

> I remember when I went to career showcase, long time ago they, somebody asked me, have you taken any courses online for personal benefit? And I was like, no I haven't. And they suggested to do it. So that kind of gave me the idea that I need more experience.

2. Application timing (n=31)

Students in this strategy described when they started applying for internships.

2a. Applied early (n=18, intern: 14, did not intern: 4):

Eighteen students described that they started applying for internships very early into their undergraduate degree program such as their freshmen or sophomore years.

Fourteen of these students secured internships although some of them failed in the initial years and four students started applying at the time of the interview when they were in freshman and sophomore years. For instance, P329, a male student in his senior year who participated in three internships starting sophomore year stated that he started seeking internships for all but large technology companies in “*freshman year, [although he] was scared of talking to big companies, just because [he] thought it was going to hinder [him] later on*”. However, he acknowledged that his perception wasn’t true as he wished to “*start talking to big companies like Google, Facebook, Apple, from the very beginning [as] they have things for freshmen*.”

Similarly, P679 is a male student in super-senior year was involved in clubs and personal projects and secured an internship as a test engineer at a defense contractor during his fifth year, stated,

> I applied from sophomore year to my senior year. I didn't start to go to career showcase, or info sessions, until my junior year, but at that point I didn't have enough experience for the jobs that I wanted to get.

Y90, a student who was a sophomore and was involved in personal projects, tutoring and coursework, did not secure an internship yet but was actively applying at the time of interview,

> I'm also visiting more career fairs and submitting more applications online to get my resume out there.

One student, P733, a female in senior year who pursued two internships emphasized to apply in early summer for large technology companies,

> Yeah, I applied to quite a few companies. I finally figured out that a lot of the big tech companies, you have to do your applications during the summer or else you're never going to get them. […] The applying in the summer thing is a big one [recommendation for other students]. I know I've said that a lot, but that's huge. I see a lot of people asking for advice

> about internships in like September. At that point, it's almost too late for them and it breaks my heart.

2b. Applied late (n=7, intern: 1, did not intern: 6):

Seven students suggested that they started applying for internships very late into their undergraduate degree program typically during or after Year 3 in the program. One of these students secured an internship while six others did not. The reasons for this strategy were challenges due to transfer from a community college, switching majors, lower GPA or lack of confidence that they are prepared for securing an internship. For instance, P401, a female student in her fifth year secured an internship in her current year as she started applying very late, specifically her fifth year due to a low GPA. When I asked her, "*Didn't you apply in junior or senior years for internships?",* she replied "*No, I haven't. […] No, I didn't even apply. I didn't apply because of my GPA, but at this point, I was like, "Okay. Well, it's better to do it even if you don't make it*".

P677, a female student in her junior year who did not secure an internship stated that she never applied for internships until her junior year. She stated:

> I started looking for internships later in my university life and I was not as prepared with technical questions as others. […] didn't start early enough in preparation, because a lot of people are already pursuing an internship their sophomore year or as I did not pursue anything, I just sort of went through coursework and pursued my personal hobbies. And then it was the start of this semester that I actually started prepping for the internship.

2c. Planning to apply soon (n=4, intern: 0, did not intern: 4):

Four students suggested that they plan to apply for internships soon as they are working on building the necessary skills needed for securing an internship. These students did not secure an internship at the time of interview and were typically freshmen or sophomores. For instance, P578 a female student in her freshman year who is a double major in Computer Engineering and Psychology, and she is actively participating in research, clubs and part-time work stated, "*I'm definitely looking for internships in the computer engineering field right now and with a high tech company, or just ones that are locally. Even startup companies. But I want to get exposure to real industry, though, within the internship".* However, when I asked her if she is "*applying to various companies actively?",* then she stated that "*No, not actively. I'm waiting until career showcase comes around so I can talk to companies straight on*".

2d. Did not apply and don't intend to (n=2, intern: 0, did not intern: 2):

Two students suggested that they do not plan to apply for internships due to either pursuing the program along with a full-time job or pursuing graduate school and spending summers to complete graduation requirements for multiple degrees they are enrolled in. These students did not secure an internship. For instance, Y81 a male student in super-senior year who was pursuing three degrees at Rose-Hulman Institute of Technology stated, "*I guess I haven't pursued [internships] at all because I thought I'd focus more on summer classes and getting the right classes that I can triple degree".*

3. Application volume (n=11)

3a. Applying to many companies (n=11, intern: 9, did not intern: 2):

Eleven students described that they applied to a lot of companies (typically more than 10) when trying to secure an internship. Nine of these students secured internships while two did not. For instance, P440, a male student in their junior year who secured two internships stated that he "*had at least 80 to 90 applications that [he] sent out*" and P329, a male student in his senior year who participated in three internships suggested that he "*applied to a lot of companies [at SHPE]. [Regarding career fair at UF], Yeah, [he] attended every year, my, those first two years, [he] did not hear back from*".

Y90, a student who was a sophomore and was involved in personal projects, tutoring and coursework, did not secure an internship yet but was actively applying to many companies reported,

> I have submitted a lot of applications online and I visited the career fair a month ago. I was able to get an interview. […] There's two main ways [in which I figure out about internship opportunities]. The first one is like the info sessions that are held on campus, because we have a lot of those, especially with time of career fair. Usually I just tried to go to as many as I can and see which ones stick. And the other way is I go online. And I just like applied to every single one that I meet the standards for.

Similarly, P692, a female student in her freshman year (sophomore at the time of the interview) who did not intern but was actively applying and networking at career fairs at the beginning of sophomore year stated,

> I've currently applied to a lot of opportunities. I'm looking for opportunities right now so I went to the career fair that was held at Georgia Tech last week for all majors and I got to talk to some companies that I already applied to. Then next week, there's also another career fair, specifically for CS students that I plan on going to in order to talk to more companies.

P692 was in the process of applying for internships as well as waiting to hear back from companies that sent her initial coding tests which she stated she were able to solve although she wasn't sure she solved the assigned problems optimally because of where she was in the degree program,

> I'm still applying, I have applied to about 40 different companies and I have heard back and taken actual coding tests for three different companies so far. […] For the majority of big-name companies like Google, Microsoft or Facebook, they have specific programs that they offer for CS majors, and those are more geared towards programming and software development. I applied to those, I did also apply to different smaller companies that have positions in sales and positions in cloud engineering intern, and positions in data analytics and cybersecurity. Basically, I applied to pretty much any position that I felt I was interested in, and I'm waiting to hear back from those opportunities. I didn't just apply to one specific title, or job, I applied to many different ones in the hopes that when I get offers, I'll have many different options to choose from.

3b. Applying to too few companies (n=14, intern: 5, did not intern: 9):

Fourteen students described that they applied to a few companies (10 or less or explicitly stated they applied to too few companies) when trying to secure an internship. Of these 14 students, five secured internships while nine did not participate in one. For instance, P591 a male student in the sophomore year found it hard to get an internship as he is not aware of positions in cybersecurity for internships and had applied to a few internships.

> Aman: Coming to the internships, through prior research, we have found that only 40% of the students actually intern before they leave college. Why do you think you haven't been able to secure an internship so far?
>
> P591: I've applied to a couple. I just think it's very competitive or maybe the ones I've been applying to have just been very competitive.

P710, a female student in her junior year who was looking for a UX design related but failed to secure one as she applied late after switching majors, did not have personal projects to show recruiters and exhibited low confidence. When I asked her, "*Did [she] apply for a lot of companies [at the career fair or online]*?", she responded, "*Maybe not a lot, but maybe like four*".

Another student, Y82 who was a male in freshman year and was planning to apply for internships in the future years applied to one company in the freshman year and stopped applying after receiving an email that he was not selected post an online application he filled,

> I wasn't confident enough to apply to any internships, but I did in fact apply to I think one internship, and then after that I didn't get in, so I didn't apply after that thinking I don't have the experience or don't have the knowledge to secure an internship.

A student who secured an internship albeit applying late and to a few companies was P401, a female student in her super-senior year who secured an internship at a small company due to her previous part-time work experience with graphic design and front-end web development skills. There was no technical interview for this position, but the employer offered her a position based on questions related to her experience in a software engineering course project or graphic design skills. She stated,

> I started applying for internships through the UF Career Resource Center. I've applied to about, I think, 10 [companies]. Then this one that I'm currently interning for replied to me right away in the next day. They called me at a set time, and they were talking about how they're looking for a front-end developer to design their new web application that they'll be releasing soon. He noticed that I've done a project for a class and we made a website. He really liked the website with how we laid it out. I was in charge of the user interface and user experience of that, so he saw that and he wanted my help with their web application.

4. Attending conferences (n=6, intern: 6, did not intern: 0)

While most students attended career fairs or company information sessions hosted by student organizations when trying to secure internships, six students described that they secured an internship via technical or professional development conferences outside of school such as The Grace Hopper Celebration (GHC) of Women in Computing, the Society of Women Engineers (SWE) conference, the National Society of Black Engineers (NSBE) Convention or the Society of Hispanic Professional Engineers (SHPE) Convention. All of these six students secured internships. For instance, P354, who is a female student in her senior year and pursued five technical internships suggested that she attended the Society of Women Engineers and Grace Hopper Celebration conference,

> I don't think I got anything [internship offers] from [Society of Women Engineers conference]. I got interview experience and I got to experience a conference, but I didn't get any internship opportunities from them. [Regarding Grace Hopper Celebration], the first time I went, that's where I got [Fortune 100 company – fourth internship offer as a network engineering intern] and I got other offers. And then the second time I went

> I got like a handful of offers. That's one of the ones where I got [Fortune 100 company – fifth internship offer – analyst intern]. And then the third time I went, I didn't look for any opportunities.

Another student, P665, who is a male student in his senior year, but was not too involved in activities outside the curriculum such as personal projects or clubs, secured six internship offers via a conference,

> One of my closest friends is in NSBE and he's active, and he saw that I was struggling to get internships. I got a couple of interviews from career showcase, but it didn't pan out. And he said, “Come to NSBE because they hand out those things left and right.” And I was like, “Yeah, sure.” It was a little expensive, but I flew out to the NSBE conference in spring, and so you’re competing with kids from all other schools there. And being from UF, we're number seven in the country and all that. People really like us. And my GPA was like a 3.46. Which, I didn't think was great, but they liked it. So being what they consider a good GPA and from a really good school and being able to pass basic questions, they really don't even look beyond what's on your resume. They check a couple things. Going to NSBE beforehand, I had never gotten a single offer. Coming out of NSBE I had six internship and coop offers. Yeah. It was really a blessing to go there. That might have been one of my only ways I could have gotten it.

P665 was asked behavioral questions during interviews for all six offers he received at the conference and one of the companies also asked him a technical coding question in addition to the behavioral questions. He decided to join a large financial technology company and continued that “*those conferences are notorious for having easier than average interviews in terms of maybe they'll ask you to iterate through a string and find all the vowels or something*”.

P645, a female student in her super senior year also secured her two internships through NSBE conference where she was asked behavioral questions for a software engineering internship position (in her junior year) and a project management intern position (in her senior year). She was involved in student organizations as a leader and had experience in customer service through various part-time jobs. Additionally, she secured two full-time offers through her connections in NSBE.

> [I secured my first internship for a defense contractor] at a conference I went to and I think I like had a pre-sign up with the company and then I guess they saw my resume and they wanted to interview me and then I had the interview. And then I clicked really well with lady, because she's from Orlando. So, we just talked, and stuff and I think she liked me. So, it just went from there. […] The National Society of Black Engineers is a national conference that happens every year. It's really good for people who are members because it’s kind of straightforward you kind of can get hired immediately because they're really trying to fill in spots.

Similarly, P329 is a male student in his senior year who participated in three internships related to software engineering roles in three fortune 500 companies: a telecom company, an industrial company and an athletic corporation. He secured his first internship at the SHPE conference which he was made aware by his friends at SHPE. Additionally, he secured the remaining two internships also at SHPE over the next two years and for all three internships he confirmed that employers asked him behavioral questions.

5. Targeting specific types of companies or roles (n=6, intern: 3, did not intern: 3)

Six students targeted specific companies or roles for internships, choosing smaller companies over large ones due to intimidation by large companies’ recruitment processes or culture, or had a preference for the interaction and responsibility in smaller firms. One student was concerned that applying to certain types of companies would hinder him pursuing open-source projects which he led due to intellectual property issues and hence was avoiding certain large corporations for internships. Of these six students, three students secured an internship and three did not participate in an internship. Additionally, one student applied to primarily project management internships for her subsequent internship after a bad experience in her first internship as a software engineering intern. For instance, P401, a female in her super-senior year, secured an internship at a small company due to her previous experience with graphic design although she applied very late for internships in her program and has a low GPA.

> Aman: What about larger tech companies like Microsoft, Google, Apple? Did you ever apply to these kinds of companies?
>
> P401: No. I've been trying to apply to smaller or not as well-known because I know competition is smaller. […] I probably have a higher chance in getting an internship with a smaller company.

Another student, P739, a female in her junior year was involved in clubs, personal projects, and explicit interview preparation and participated in three internships at small companies but wasn't confident that she could secure a job at a large technology company.

> Aman: In the survey you mentioned that you want to work for a medium-sized company, not a large or established corporation, let's say Microsoft, Facebook, or Google. Why is that? Like, is that specifically related to confidence, or is that your personal choice?
>
> P739: Yeah, I think that would be related to confidence, and actually I was thinking the other day how I'd probably really prefer a small company, whatever constitutes that, simply because I feel like at a big company I would be a lot more willing ... Or, I would just sit back more and feel like, "Oh, someone else should be doing this because I'm not qualified," and that sort of thing. I wouldn't be pushing myself to grow.
>
> Aman: So, did you apply to those companies for internships, or no?
>
> P739: I did one interview with Microsoft, and I would take any internship. Any experience is great. I try to see the good in anything. But really, I wouldn't be super-interested in that. But I'm excited for the internship I have this summer because it's a 12-person company.

P739 confirmed that she cancelled subsequent interviews with Microsoft as she accepted the offer from the small company.

On the contrary, students who did not participate in internships were also targeting specific companies. For instance, P690, a male student in senior year who had not participated in an internship was specifically applying to smaller companies because of intimidation and lack of confidence,

> I switched into the computer science major after my first year, so my Sophomore year of college I felt like I was playing catch up with classes and didn't really have the experience for an internship. My Junior year I attended career fair, but the large companies and lots of people made it feel intimidating. Additionally, I feel like I would not fit in a large company culture, and tend to stray away from these big events with big companies. I also have fear of not being qualified enough or not fitting into companies.

P341 is a female student in her senior year who is involved in game jams, personal projects and part time technical consulting. She was not able to secure an internship due to low confidence, less preparation with interviews when she had applied, or her alternate priorities on coursework to ensure she graduated early. She did have a full-time job offer after graduation but did not participate in any internships. When I asked her if she applied to large companies like Microsoft or Google for full-time positions, she stated,

> I haven't given it a try to apply to those companies, just because they're too large for me.

6. Emailing recruiters (n=4, intern: 4, did not intern: 0)

Two students described that they cold-emailed recruiters and two students emailed known recruiters when trying to secure an interview for an internship and all of these students secured an internship. P440, a junior male student who secured two internships shared,

> I think one of the major challenges was actually getting interviews. In the start, I was not getting them at all. I think I wasn't taking it very seriously in the start, in the sense that I wasn't actively applying to a lot of places. […]. So that was a very important challenge because I realized that I wasn't catering myself to what organizations were looking for. So, to bridge that gap, after speaking to a bunch of people and realizing what I needed to wrap my skills up on, and basically buff up my resume. That was step one.

> So as soon as I had that kind of built, and then I started spending more time in putting out applications, talking to more recruiters, sometimes even sending them cold emails just for the heck of it. […] And then the way I kind of overcame it was obviously, made my resume better, sending out a lot more applications, emailing everyone and also I just applied to a whole bunch more places.

7. Leveraging referrals (n=2, intern: 2, did not intern: 0)

Two students described that they sought referrals from seniors or alumni as one of the strategies to secure an interview for an internship. These students met the seniors and alumni through student organizations. Both of these students secured internships. For instance, P354, who is a female student in her senior year and pursued five technical internships failed to secure an internship during her freshman year. However, she was able to secure one during the sophomore year owing to her resilience, grit, involvement in the preparation process and support from a senior student mentor who referred her for an industry internship.

> And then sophomore year came around, same time of your career showcase. And at the time I joined [anonymous student organization] and I met this lady or this girl who's the president or something. I remember I came up to her and again I was just adamant on learning and I went up to her and I was like, “Hey, this program sounds really cool because it's education and I want to give back while also building my technical skills.” It was like a beautiful combination and they needed a social media chair and I was like, “Hey, I'll do it.” […] And they gave me a social media chair position because they needed one. So that gave me the experience to be social media chair. And then I guess [Anonymous-club president], I don't know what she saw in me, but she was like, “Hey I worked at [a Big Five United States tech company], do you want a referral?” And I was like, “Yes.” So she gave me a referral, which then I guess […] pushes your resume up to be seen.”

After the referral, P354 first completed a phone screen and then was invited to on-site interviews which consisted of technical and behavioral questions. She excelled in the interviews and secured her first internship.

Another student, P152, a female in her junior year in the online CS program secured two internships. She secured her first internship after a referral from her professor at a community college and her participation in personal projects.

> So I was taking classes at community college and I impressed one of my teachers, but actually, even outside of that, I decided to just apply to some internships offered in the area. So I went online and started looking for openings, and I applied to an internship. And later on I was talking to my teacher in class about me applying, and I was telling her that that company was one that I was applying to. And she told me that she knew the CEO, and she just put in a good word for me. And then, I don't know if that helped, but I had an interview scheduled with them anyways, so after I went in, I had the interview.

In the interview, she was asked behavioral questions, and she attributed her securing an internship to her personal projects and the referral by the professor.

> I think I was mostly offered my internship because I had good side projects at the time that they were able to go and see through my GitHub, and also because my teacher recommended me. And I also think I did a good job in the interview, as in they liked me when we were talking.

8. Resume/cover letter tailoring (n=2, intern: 2, did not intern: 0)

Two students described that they were tailoring their resume or cover letter for specific companies or using keywords which are sought by recruiters via applicant tracking systems (ATSs) Both of these students participated in internships. For instance, P440, a male student in their junior year who secured two internships suggested,

> There are two kind of major skills that I've been focusing on for the past year. And I think that's what a lot of recruiters are also looking for right now. […] The first part of it is getting ramped up, making your resume, bucking up your resume with a whole bunch of different technologies because it generalizes it for all of the recruiters. So, I think my first skill that I wanted to build was being able to generate a breadth of knowledge within there. So right now, if you look at my resume, for example, I try to put in as many buzzwords as I can so that it just engages some recruiter at some point in time. And so that's what I kind of focused on before. And then right after, I realize that I had enough content on my resume for it to

be looked at by a recruiter and kind of pass me over to the interviewing phase.

Another student, P739, a female in her junior year was involved in clubs, personal projects, and explicit interview preparation and participated in three internships stated that she would “cater cover letters and resumes to the position” when applying for internships.

Theme 2. Strategies specific to clearing interviews

These strategies pertained to a student securing an interview. We found two categories in this theme. We further bifurcated this data based on student participation in an internship (see Figure 4-10)

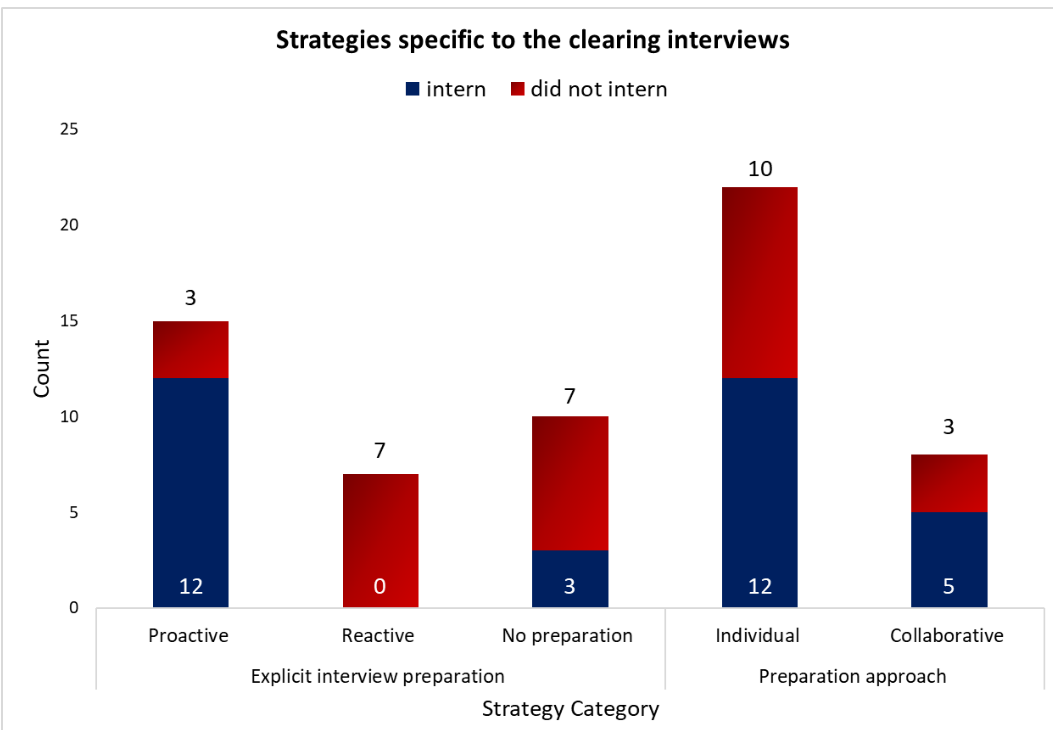


Figure 4-10. Strategies students followed specific to clearing interviews

9. Explicit interview preparation (n=32)

Students in this strategy described how they approached technical or behavioral interview preparation.

9a. Proactive (n=15, intern: 12, did not intern: 3):

Fifteen students described that they were actively researching companies before attending career fairs to talk to recruiters or were preparing for technical or behavioral interviews before receiving a chance to interview in order to secure an internship. Regarding technical interview preparation, students who secured internships at top companies would practice 30 to 90 questions on websites such as HackerRank, Leetcode, Firecode, etc. or used the Cracking the Coding Interview book. One student also practiced these problems as a part of the competitive programming team. Most of these students had a proactive approach after they had failed to secure an internship initially. 12 of these 15 students interned while three students were in freshman or sophomore year and suggested they would apply for an internship in the future. For instance, P440, a male student in their junior year who secured two internships shared his process of proactive explicit interview preparation first independently and then collaboratively for two and a half months meeting almost every day with his two peers.

> I started focusing on data structures and algorithms. So that was entirely focused on doing LeetCode questions and pairing up with my friends and working with each other to keep each other accountable to solve more problems and being able to interview better. […] My technical prep started when I started my data structures and algorithm course. And I realized that companies, as soon as you have the interview, ask content from the data structures and algorithms course. So, in terms of the technical interview, I realized what I need to kind of focus on. So, I started by myself, I haven't paired up with anybody. And I just started tackling random problems of the code. I didn't have any sort of methodology for it in the start, because I was like I don't know what I'm prepping for. But I know all of these types of things, I could potentially be asked something similar to this in a technical interview. And so in the start, that's what I kind of did. And it helped me to an extent, and I was able to get an internship [first internship at a financial institution] and they asked me a technical question, and I was able to solve it really quick, and that's what eventually I think helped me get the internship.

P440 realized that with independent practice, he could secure his first internship at a large Fortune 100 financial institution, but he needed to collaborate with peers in order to secure an internship at a Big Five United States tech company as collaboration provided him with more accountability and knowledge on what the interviewer was looking for,

> But then when I started looking at other companies that I was applying for as well, I realized that they were asking for a lot more in-depth knowledge of the technical things that I was learning in data structures and algorithms. So that's when I realized that I needed to ramp up my skills entirely.
>
> And that's when I started trying to buddy up with people around me. So I asked a couple of people in some of my classes and some of my other friend. And I was like, “What are you guys doing for your technical prep right now?” And everyone is kind of doing the same thing that I was before and I was like, “It kind of works, but we kind of need to take it to the next level now.” And so we told each other that we wanted to hold each other accountable.
>
> And what we ended up creating is a huge Excel omni grid we called it. And in that omni grid, we had a bunch of questions that we knew we had to target for a specific company that we already had interviews to. We had columns for me and my other two buddies. And what we ended up doing is we had mock interview sessions.
>
> So at home, whenever any one of us was free, we'd solve our own questions whenever we wanted. But when we met up, we tried to look at questions that one person had not solved, and two people had solved already, and tried to ask the person, the question that the two people had already solved [but the interviewee hadn’t].
>
> And so that puts us into the interviewer situation, and it puts the other person into the interviewee situation, and it gets people thinking into that mindset. […] We'd actually try to represent a mock interview. And I think the skills that […] we kind of developed in that process are extremely valuable because we learned to do number one, keep each other accountable was the major thing. Because if I do not do a question the entire day, the other two will just be like, “What are you doing? You need to wrap up your skills.” […]
>
> Since all three of us have prepped so hard, by the time we interviewed on site at [Big Five United States tech company], we were all three of us were

> at the stage that we could tackle any difficulty level problem if it was thrown to us. And we kind of knew how to get hints in what the interviewers were looking for. Because we had that process of being interviewers, we knew what we were looking for when we were interviewing each other.

P440 practiced roughly 60 Leetcode questions in detail and 90 more questions on the whiteboard independently or collaboratively. He also explained that he attempted Leetcode questions himself first and if he got stuck for too long then would look at the solution but would revisit the problem after a certain interval to practice the question again later. This mechanism allowed him to learn through deliberate spaced practice and he started seeing and applying patterns across problems,

> My thought process was I should only be spending 30 minutes on a question. And I should only go up to 45 minutes if I think the question is extremely important. And that 30 minutes, what I try to do is first try to think about a solution, and I try to see if I can come up with a solution for that question from the get go. So, first the solution and then try to see how can I optimize it. And try to see if there’s another programming paradigm that I need to incorporate into the solution. So that's mainly the first 10 to 15 minutes of my thought process whenever I'm looking at a question.
>
> And then when I have this very, very rough, pseudo code kind of built out already, that's when I kind of peek at the solution window or the discussion window on LeetCode and try to see if I'm thinking along the right tracks. And if I realize that I'm not thinking along the right tracks at all, then I stop what I'm doing entirely. And I just look at the LeetCode solution directly. Because I know that since I didn't think of it, I know I needed to expose myself to the solution at least once. And I wouldn't solve the question right after looking at the solution, what we did is I just highlighted the question as yellow in my box. So what that meant is I had do revisit it.
>
> So questions like those, I know that I was exposed to them already. So after a couple of days or so I'd go back into the question and solve it again in 30 minutes span. But this time, I had a whole bunch of other questions. So I might not necessarily remember the exact details of the question, but I knew the approach that I would have to take for that question. And sometimes what would happen is I'd have to use that same approach for different questions as well. And so that really helped out as well. Because if I had seen one solution already, then I'm able to use that same idea and apply to different questions as well.

Another student, P794, a male in junior year who was involved in clubs, personal projects, secured three internships, including two at a Big Five United States tech company described his preparation process for technical interviews,

> I did probably 60 questions, which is very on the lower end. I know a lot of people who do 300+ to get these jobs. And I did a mixed bag. So, I did five dynamic programming questions, five tree problems, five graph problems, so forth, just to like have a general grasp of how to handle these problems. Because from my experience, the people who do hundreds on hundreds memorize solutions, and they couldn't tell me how to do something very similar to something they've seen. So I was trying to understand how to solve any given problem. So, if I want to find the width of a tree, that sounds like a Breadth First search. Or all these kinds of things. I learned the general process of how to handle things. And I did a lot of mock interviews. So, me and my friends, I'd mock interview one of them, they'd mock interview me. Then we'd handle the next guy. So, it was probably 15, 20 mock interviews throughout the semester.

Similarly, P152, a female student in her junior year in the online CS program secured two internships after proactive practice shared her preparation strategy,

> Usually if I know that I need to apply to interviews in the next month or two, I'll go on LeetCode, and they have a Top 100 problems to practice before interviews, and I'll go and do all of those. And then maybe I'll pick a few random, hard questions from HackerRank if I feel like I need more, extra help, but usually not. And I know that if I'm going to apply to a job where it is specifically mentioned, like, you should have good SQL skills or something, which sometimes I'm weak at, I'll go to HackerRank and just practice a couple of those problems.

Another student, P739, a female in her junior year who participated in three internships stated that she proactively prepped for interviews,

> P739: I practice problems and stuff. I don't know if maybe those are more of interview practice, like to get the job, and I also try to develop my soft skills and stuff too with being involved in clubs and that kind of thing, and working on personal development as well. […] I have a couple of interview books that have code problems and that kind of thing, and the walkthrough solutions, and you're studying different common patterns and stuff. […]
>
> Aman: Have you planned all this, which is like you do two to three questions a week, or is it random?

> P739: No, every quarter I'm like, "Oh, I'm going to do this, and I'm going to have an hour, or a half an hour every day at this one time, and then try to do three hours on the weekend or something," because also I do enjoy it, but I find usually, as the quarter goes on for our 10-week quarter, by the end of it I'm usually working on course stuff, and it usually doesn't happen, I guess.

She confirmed that for the first three weeks she would follow the above plan and then gradually she will have less time to focus on interview preparation due to her coursework.

Y91, a female student who was a freshmen involved in personal projects, hackathons, and clubs was participating in mock interviews as well as using flash cards to prepare for interviews, although she didn't apply for any internships, but she planned to in the following semester,

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

> Y91: I am taking a composition class and have flashcards to prepare for interviews, and I plan to go to the career center to do a mock interview. […] So, here at Rose we have career services and, you can schedule mock interviews there. So, that way when you go into an actual internship interview, you're not completely unprepared for what to expect. […] The composition helps me to write responses more efficiently, more cohesively when filling out an online application. And then, the interview cards [provided to her by the career center], just say like, they gave like a scenario, and how would you respond to that?

9b. Reactive (n=7, intern: 0, did not intern: 7):

Seven students described that they were preparing for technical or behavioral interviews when they were invited to an interview or did some preparation right before the career fair. These students would have less experience and would passively work on the preparation compared to students in the above proactive category. All of these students did not participate in an internship and one of them was able to secure a full-time job after changing his approach from reactive to proactive. For instance, P677, a female in her junior year who did not intern yet described that she was involved in clubs and personal projects and started explicitly preparing for interviews right before the career fair which she wished she knew “*how to prepare for”* earlier*,*

> I started looking for internships later in my university life and I was not as prepared with technical questions as others. […] Currently, I'm in the process of continuing to study technical interview questions. […] I've been using LeetCode to do a few, even bought my own whiteboard at home to start doing that. And then I also happened to be reviewing a lot of the data structures using websites like GeeksforGeeks. […] Yeah, I started preparing for it actually around the time career fair started. So, it wasn't even like beginning a fall. I didn't really prep for too long. […] I didn't go over too many LeetCode questions, and I did look over the kind of questions that the companies could ask [on Glassdoor].

P591 is a male student in the sophomore year was involved in clubs and personal projects and he applied to a few internships and failed. He shared his experience as,

> Aman: How are you preparing to get these internships? Apart from applying, are you actively solving interview questions online?
>
> P591: For the Amazon interview, they had a different application system. It had an assessment that I had to take. To prepare for that, I did solve some problems. They were coding problems. They'd give you a problem and some code to solve it. I did practice some of those before.
>
> Aman: Are you still actively preparing for interviews or no?
>
> P591: Right now, no. I think this summer I'm going to work on a project so that I can show people or for internships or jobs that I apply to. I guess, right before the time comes, then I guess I'd prepare a little bit more for the interview.

Similarly, P341, a female student in her senior year was involved in game jams, personal projects and part time technical consulting did not do any structured explicit practice of interview questions but rather would prepare right before the interviews. She stated that she used Glassdoor and guides from companies “*a few times before my interviews this past week*” to prepare for her interview with American Express. Further she added that “*before the Arizona [interview] last Friday or last Thursday, [she] spent a few days, two hours each, looking at the top 50 Java questions. And then, if I ran out, I just go to the next website with those top 50 interview questions”.* However, she confirmed she did not prepare before applying.

> Aman: But this was after you started applying, right? Not anything before that.
>
> P341: Right. Because they gave me offers [interviews], or like, “Hey, let's do a phone interview.” That's when I started, like, “Okay, I should get ready for the expected of what they ask me.” Behavioral questions, for example, just so I don't get stuck.”
>
> Aman: A lot of students, before they even start applying, they start preparing for their interview processes. Why didn't you take that route?
>
> P341: My confidence was low already. So, I had to make sure that I actually get some attention from the interviewers. So, after I got, maybe, oh, this is the time. I have a chance. So, that's when I started looking.

P412, a male student in his super-senior year was involved in courses and applied late to internships couldn’t clear technical interviews when he used a more reactive or passive approach to prepare for internships.

> Was I preparing? I guess aside from just resume preparation, I guess not really much. Yeah. Because my friends were kind of the same way. We would just wait. It would always happen or it would be like showcase [career fair] is in two days, we got to get ready. So, we would kind of just meet up and then just research the companies and just try to talk to each other about it. Sometimes we would do practice talks, like elevator speeches or whatever. But I guess that was the extent of it. Myself, I didn't really prepare that much.

P412 then changed his approach to more proactive preparation after failure in an interview for an internship with Facebook a year ago, which “*motivated [him] to get the [Cracking the Coding Interview] book and keep practicing”* the following summer. After this proactive preparation, he was able to succeed in technical interviews for a full-time job at a large infrastructure technology company and secured a position,

> Then also over the summer, I use you've probably heard of the Cracking the Coding Interview book. So I was just going through practice questions, trying to practice for the interviews. [For the book], because I mainly use C++ for object oriented programming, I would go through the introduction, which kind of goes like an overview of creating algorithms and getting ready for the interview. Then [for] practice problems, I would first read the question and then because the lady that wrote the book also provides these steps of how to solve a problem, meaning that I don't just read the problem and start coding. So, her steps were read the problem, gather all of the information, go through an example, and then write an algorithm on paper, no coding, just algorithm steps and then optimized algorithm. Then test it, and then once it's good, then convert it to code.
>
> So, I would try to do that. I would try to do it all on paper. I would do those steps, write the algorithm and then try to improve it. Then once I thought it, and then I would write it in code on paper because that's how it'd be in the interview. So once I wrote it on code, I would then write it on the computer and then test it and then see if it worked or not. If it didn't work, then I would fix it. If I couldn't find a solution, then I would look for an answer online and try to see what I was doing wrong. Since the semester started, I kind of haven't spent much time on that, but I probably finished about 20 to 30 [questions].

9c. No preparation (n=10, intern: 3, did not intern: 7):

Ten students described that they did not prepare for technical or behavioral interviews but only worked on creating their resume. Of these ten students, seven students did not participate in an internship, but three students were able to secure an internship. The latter three students demonstrated confidence in their technical expertise within their major. However, they all obtained internships through behavioral interviews in the absence of technical interviews. For instance, P578 a female in her freshman year who did not participate in internships stated that she was “*not preparing*” for coding interviews as she is “*more focused on other things and school and research*”.

P690, a male student in senior year did not participate in an internship and stated that he did not do any preparation for the interview process except getting his resume reviewed by the career center,

> I haven't really ventured into taking, I know I have some friends who do like leetcode and stuff like that, but I haven't really touched anything like that. It's mainly just classes right now.

Similarly, Y90, a student who was a sophomore and was involved in personal projects, tutoring and coursework, did not secure an internship but was actively applying. They were relying on coursework for them to get an internship and did not work on any additional preparation,

> [I am doing no preparation] at the moment, right now I'm trying to like reinforced my technical knowledge just through like my courses and through my teaching job, which I recognize it's not going to last in the long run. But I think for now that should suffice until my courses get a little easier and I can focus more on internship preparation. […] I spend most of that time focusing on my academics and making sure that was a solid foundation. This year, I'm finishing up some of the core classes in my major (namely Programming Language Concepts and Computer Architecture) which will make me more appealing to companies.

Two students who were able to secure internships, also did not prepare for internships. P219 who is a double major in mathematics and CS and identified himself as a male student in senior year secured an internship related to statistical modeling at a large energy company stated,

> Aman: Did you prepare for that specific company [where he interned] or for the interview? […] Reading on Glassdoor what kind of interview you might expect?
>
> P219: No, but the thing is also is that a lot of these interview questions that they give you in computer science are very textbook-y, very discrete math type of thinking, and if you really understand algorithms, you understand turning machines and state machines and graph theory and stuff, you can pretty much derive most of these algorithms right off the top of your head. You don't really need to study at all.

Similarly, P733, a female in senior year who was involved in personal projects and hackathons and participated in two internships related to data science including one at a Big Five United States tech company shared,

> I didn't prepare much, mostly because I was afraid that if I learned all the secrets to technical interviews and what not, that I would just get too stuck in what I thought I knew about the work and it would interfere with my natural problem solving ability. I stayed away from all of that and just kind of winged it.

P733 was able to secure her first internship at a medium sized company in the freshman year without a technical interview and had to clear seven technical and behavioral interviews to secure the second internship at a Big Five United States technology company. She also cleared technical phone interviews and received an offer from another Big Five United States technology company but she chose the place where she interned as they allowed her to visit onsite and talk to employees,

> But that interview [with another Big Five United States tech company] was weird, because I only did phone interviews and then he immediately gave me an offer. They wouldn't let me visit, they wouldn't let me talk to anybody else. I felt really weird about that, so I let that one go.

10. Preparation approach (n=20)

Students in this strategy described whether they prepared for technical or behavioral interviews individually or collaborating with a peer, mentor or industry professional. Note that all students who used collaborative methods to prepare for interviews first used individual preparation methods.

10a. Individual (n=20, intern: 12, did not intern: 10):

Twenty students described that they prepared for technical or behavioral interviews by themselves using resources such as Leetcode, Hackerrank, GeeksforGeeks, Glassdoor, Cracking the Coding Interview book, and researched about companies or behavioral questions on the web. Of these 20 students, 12 of them participated in an internship and 10 did not participate.

10b. Collaborative (n=8, intern: 5, did not intern: 3):

Eight students described that they prepared for technical or behavioral interviews by forming peer groups and conducting mock interviews with one another or they sought mock interviews with industry professionals, mentors, upperclassmen in clubs, or at university career centers. Five of these students were able to secure internships and three students did not participate in an internship. For instance, Y84 was a female student in freshman year who had not participated in an internship but was actively building skills to participate in an internship in the future through her involvement in coursework, clubs and explicit interview preparation. She was a member of WOLFPAC club at Rose-Hulman Institute of Technology which stands for Women of Like Fields Passionate About Computing. She stated that WOLFPAC had *"a meeting on Monday for all grades - freshmen, sophomores, juniors and seniors [where they do] 10 minute mock interviews".* These interviews are conducted by mostly "*upperclassmen, [who] have been to the career fairs and had interviews. They teach [them] how to do that".* Additionally, she intends to participate in "campus-wide mock trial of interviews" which were conducted by the *"Center of Diversity at Rose-Hulman"* right before the career fair.

Theme 3. Generic strategies

Students also used some generic strategies to succeed in the employment recruitment process. We found four categories in this theme (see Figure 4-10).

11. Guidance and support from mentors and connections (n=19, intern: 10, did not intern: 9)

Nineteen students described that they were supported by mentors or connections (such as friends, family members, faculty members, peers, seniors, or career center advisors) when trying to secure internships. Of these 19 students, 9 students did not intern and 10 were able to secure internship(s). The mentors were senior students in clubs or fraternities, professors, past-managers or colleagues in internships, or industry professionals. These mentors and connections supported students in providing referrals, developing a support network, providing strategies on how to get interviews or excel in interviews, or negotiating offers.

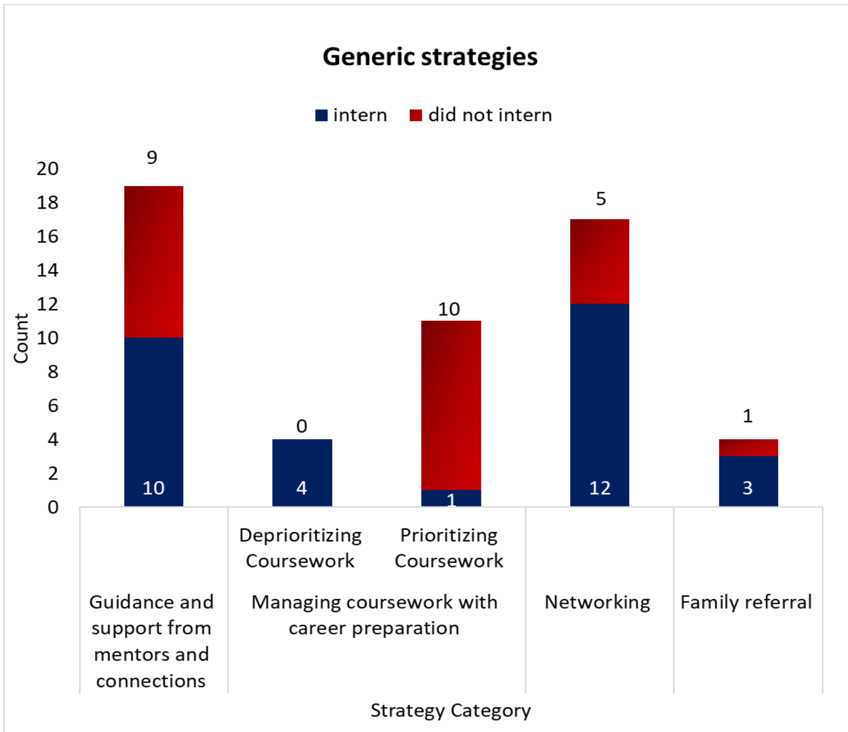


Figure 4-10. Generic strategies students used when approaching employment recruitment process

For instance, P665, a male student in his senior year who interned, had a friend (connection) in a Greek organization who told him to attend the NSBE conference in the junior year to secure internships. Similarly, P354, who is a female student in her senior year and pursued five technical internships shared that her mentors provided extensive guidance on how to excel in the interviews, alleviated her imposter syndrome, referred her for positions, gave her tips to negotiate offers, and helped her in practicing mock interviews:

> Mentors is a big thing. I had a lot of mentors in different organizations, whether it was alumni mentors or career mentors. I was really bad at interviewing, terrible at interviews. […] It was during my first internship at [a Big Five United States tech company] and I was trying to practice how to do PM interviews. Because CS interviews you do cracking the code interview, and you have to learn technical questions. For PM interviews it's the same thing, but it's a different science. You have to know how to answer PM questions and design questions and ask the right questions to be able to craft the project. And I was so, so bad at it. One of my friends also in [anonymous student organization] who was actually my mentor’s mentor, I don't know, an interest in me and decided to help me out. And he's also, I credit so much of my life to him also because he would spend hours on the phone with me, training me to interview and also reminding me that I could do it. But really getting into the nitty gritty of like, “Hey, this is how you answer questions or here's some tips and tricks on how to interview. […] He helped me a lot with communication skills. […] He gave me this trick of writing down questions that I think people would ask during interviews. So whether if it was generic questions, like, “What is your biggest weakness and biggest strength?” or an actual [program manager] question or maybe a technical question of, “Can you explain this problem in your project that you did at your previous internship?” He gave me this tip of writing out all the questions and then right before the interview, writing all my answers down so that my brain already knew the answers ahead of time. It was a really great way for me to practice before these interviews.

Additionally, P645 is a female in her super senior year who secured two internships through technical conferences. She had a mentor who was a professor and gave her career advice,

> I have one professor who I really like and she helped me a lot. She was really helpful because she's also a black female. She was really helpful in terms of like helping me out career-wise or education-wise like scholarships or conferences to attend and stuff like that.

P679 is a male student in super-senior year was involved in clubs and personal projects. He secured an internship as a test engineer at a defense contractor and shared advice he received from recruiters, family, and other connections on the job seeking process,

> So, a lot of [recruiters] get the questions of, “How do I get this job,” or, “How do I do good in an interview?” So, they usually tend to give advice

> on that unless you ask them about industry, then they'll talk to you about that, but the advice that they usually give is now, in this time and age, it's less dependent on the grades. Obviously, they don't want you to be failing your classes, because that doesn't show a good work ethic. So, as long as you have a good work ethic, but they really stress having external experience. So, whether that's doing personal projects on the side, or joining a design group, or just doing research at the school, or on your own, and having some sort of portfolio to show. To them, that's more important, because that means that you actually have some tangible evidence that you know what you're doing, and that you're willing to put in the work, rather than just maintaining the status quo and getting all A's in your classes. They'd rather see you more diversify yourself, and learn new things that aren't required of you.

He took this advice and was continuously learning new skills every month and pursued several personal projects and got involved in the Gatorloop team.

Students who did not secure internships also had mentors and connections. For instance, P674 a male student in his super-senior year who did not intern stated,

> So, I do have my bigs from the organizations I'm a part of, who are also computer science majors, and are currently working in the industry, who have told me about their experiences, and things. They were the ones that helped guide me through my courses and then applying for jobs and things like that.

Similarly, P785, a female student in her senior year who did not intern added,

> I have a family relative […] who works for Google. So one of the advices that I get is just find a project that you're interested, and just work on that because personal projects take you a long way. And not only for the purpose of getting a job, but just to develop skills, personal projects, he said, are probably the most effective for learning, according to him. So that's probably the biggest advice that I've gotten.

Y82 was another student, who was a male in freshman year and was planning to apply for internships in the future years and had a mentor who was a senior student that was assigned to him after he requested one. At his university, students can request upperclassmen mentors as a part of Computer Science & Software Engineering mentorship program,

> In our school, we have a CSSE mentorship program, so basically they pair us up with one senior mentor and that mentor will stay with you for the rest of the freshman year. If I have any questions about the CS curriculum or how they got the internship, or what are some ways I can get improve my chances of getting an internship […]. In terms of internships, she told me […to] do networking, and then by next year you'll gain a lot of knowledge in your curriculum, and that's when you need to apply. She gave me tips like make sure you have a firm handshake and have a spotless résumé, and then she checked my résumé.

Y84 was a female student in freshman year who had not participated in an internship but was actively building skills to participate in an internship in the future through her involvement in coursework, clubs and explicit interview preparation. She stated that her mentor, an upperclassman who she got paired to gave her the following advice,

> She [her mentor] said that a lot of internships, especially want students who have had even some minimal experience with Python or JavaScript. She said she got an internship her sophomore and junior year. She said that to, even though I've never had a big experience with coding. That I should still attend career fairs and that anything can happen.

12. Managing coursework with career preparation (n=15)

12a. Deprioritizing Coursework (n=4, intern: 4, did not intern: 0)

Four students described that they balanced coursework with career preparation by deprioritizing coursework and focusing on more external involvement or interview preparation in order to secure an internship. These students were comfortable sacrificing their grades (3) or having a lower GPA in order for them to secure employment and all four of them secured internships. For instance, P440, a male student in his junior year who secured two internships stated,

> We [group of three peers practicing technical interviews] realized that since we had interviews already at all these major companies, we realized that we had to step our game up in terms of getting the job now. So, we didn't give as much priority as we should have to class coursework, and we kind of prioritized other things more than we did class work. So before

doing my interview prep, I had a 4.0 GPA, after taking my interview prep, I can't say I have a 4.0 GPA anymore.

Although P440 received counter advice from his parents, he still pursued these opportunities,

> My parents they were like, “Oh, grades are everything. If you don't get good grades, you're not going to go anywhere.” And that's the mentality that I was growing up with and so I knew I had to maintain my 4.0 GPA. But after getting to college, talking to all these people and understanding that it really isn't, if I'm not learning and applying the skills that are required to get jobs, I'm not going to be a very successful person if I'm just focusing on my schoolwork. I will get a job, but I wouldn't get the best jobs that I really wanted. And so, I wish I would have applied all of these things that I'm currently in earlier than when I actually started thinking about them.

Similarly, P665, who is a male student in his senior year and secured an internship stated that he prioritized the job application process over coursework,

> If I have proof that I'm going to interview and I have to fly out because they're flying me out, let me miss class. Let me miss a quiz, because your quiz isn't more important than my career.

12b. Prioritizing Coursework (n=11, intern: 1, did not intern: 10)

Eleven students described that they prioritized coursework over career preparation as they had a low GPA or were early into the program. These students would often skip career fairs over attending classes or were less involved in extracurricular activities. Of these 11 students, 10 students did not intern and one was able to secure an internship. For instance, when I asked P223, a male student in their sophomore year who was not able to secure an internship, “*Why didn't [he] attend the career fair, both the showcase, as well as the computer science one?*”, he stated,

> I had class, unfortunately. […] This semester, I just wasn't able to fit it in my schedule.

P199 was a male student in sophomore year at the University of Central Florida, who was involved in personal projects, hackathons, and clubs but failed to secure an internship as he was focused more on courses. When I asked him if he attended career fairs at his university, he responded,

> I have not attended any of them. No. They usually conflicted with my class schedule.

Similarly, P785, a female student in her senior year who did not intern stated that she had to focus on her coursework over internship seeking at the school career fair due to a low GPA,

> Aman: Did you apply [to internships] this fall in the career fair?
>
> P785: Yes, I applied mostly online because I couldn't go to these career things. I had a Microprocessor lab that day.
>
> Aman: So why did you pick Micro P over going to a career fair because that's a one-day event, right?
>
> P785: It's just very intense. I took data logic and I knew, what you miss in one lab […], "You will pay that later." […] At that time, I was very behind on the course, and I was working on actively trying to get my GPA up. There's like, "Okay, make my GPA better to get a job, but if I try to go to the job and then don't do well it's going to be harder.

Another student, P341, a female in senior year did not participate in an internship due to her priority to graduate early.

> The reason I didn't pursue an internship was because I was still with the contractor, as an independent contractor [working part-time in technical support]. During the summer, I've been taking classes. Some people take it off. I didn't want to finish too late into my career, so instead of having internships during that time, where people take classes, I took classes instead of finding those internships. […] I wanted to graduate on time because I felt like I was already behind [due to transfer], compared to my other classmates that I graduated high school.

On the contrary, there was one student, P219, a double major (Math + CS) was a male in his senior year who secured an internship although he was prioritizing coursework and trying to build skills by taking challenging courses. He preferred selfdirected learning and demonstrated agency through his involvement in clubs, hackathons, personal projects and research,

> I could take easier classes if I wanted to, but I don't. I take harder classes. I could've taken, I don't know, some kind of easy advertising for liberal arts, whatever, I don't know. There's so many easy things that I could've studied, but instead, I want to challenge myself.

13. Networking (n=17, intern: 12, did not intern: 5)

Seventeen students described that networking with recruiters, peers or seniors who have undergone through the similar job-seeking process was a strategy they adopted. Students would network at company information sessions, events hosted by student organizations, career fairs, hackathons, and conferences. Twelve of these 17 students were able to secure internships and five did not participate in an internship. For instance, P440, a male student in their junior year who secured two internships stated,

> One of the skills that I've learned from going to a lot of club meetings and putting myself out there a lot is networking. I've realized that when I got into the degree, I wasn't so good at confronting people, talking to them, going up to people, asking them about their experiences, and learning from things that they've done well, and things that they haven't done so well in my opinion. So networking has been a very important skill for me, because I've networked with so many people over the past year in my degree program that I didn't expect to before. But being able to learn from other people's mistakes was something that I learned how to do. And seeing how other people have failed their technical interviews, they tell me what they thought they could have done better, and then I kind of put myself in that situation as well and start thinking about how I would react in that situation. So I think networking gave me those skills that really took me to the next level as well.

Similarly, when I asked P329, a male student in his senior year who participated in three internships on what types of engagement he had for professional development outside of courses, he said,

> Definitely networking. Sometimes the recruiters or the engineers that go to the conference are the same. If you talk to them one year, they remember you the next so it becomes easier and that definitely helps. […] The SHPE

> conferences gave me the opportunity. That's where I, for some reason, until this year and last year, I wasn't getting interviews here at [anonymous university]. Then the SHPE conferences I was killing it and just getting interviews and offers, so it definitely helped me get experience and get comfortable talking to recruiters and everything like that.

P645, a female student in her super senior year who secured two internships through technical conferences, shared that she applied the following strategy when applying to full-time roles which got her two offers,

> So, like every role I did I made sure it was something that I really wanted to do and I had a full, I don't know like a preparation for it. So it wasn't just handing out my resume like I would used to do. I really made sure I was doing it people who had, if I had people who had connections in that company I would have them help me. Or if I had connections, I'd make sure I'd pull those strings.

P679 is a male student in super-senior year was involved in clubs and personal projects. He actively networked with recruiters at company information sessions,

> When I was in freshman year, and sophomore, it was more difficult [to reach out to recruiters and industry professionals], but then I realized if you don't put your foot in the door and start a conversation, there won't be one, because people in industry aren't going to start one with you. So, a lot of it stemmed with going to career showcases, but more in particular going to their info sessions, where it's smaller, where then you can meet them one-on-one, and have a more in depth conversation, and then you can talk to them afterwards. Then, also through different organizations, too, that will have different recruiters come and then you can network with them, and they'll pass you on to different engineers. Then, just through, I guess, family networks too. I have a lot of engineers that I know personally, whether it's at the school or at home, where I can talk to, and get a feel of what's going on in industry at the time.

P679 secured an internship as a test engineer at a large defense contractor through a recruiter he met at a private event which was held for the Gatorloop team which he was involved in,

> Aman: Can you tell me the story of how you got the internship for [anonymous defense contractor], as a test engineer?

P679: So, it was mainly through... Well, I have to give the credit to Gatorloop, pretty much. So, our [one of the leaders of the club] this year was an intern at [anonymous defense contractor] last year, and they gave us funding last year, and this upcoming year for our designs. So, it was through that funding, and just having a previous intern talk to a recruiter, and bring them to the shop, and get them involved in our design process, and knowing who we are. So, I met the recruiter in a private info session, at our shop for Gatorloop, where I got to talk to her about just what my interests are, talk about [anonymous defense contractor] in general, and then just talk about the club, because they just want to know that you're, I guess, a normal person, and you actually have aspirations. In those smaller setting, it's good for them to know, and to get to know who you are, rather than just what you do […]. So, it was actually that recruiter told us not to go to career showcase, because she already know who we were at that point. So, we didn't need to shake her hand, and introduce ourselves again, because she already knew. She pushed us along in the step, and said, “If you guys need anything,” because she understands that on top of our class loads, we have this club that we do things for, and we spend a lot of time doing for. So, when they had private interviews just for UF students, it was good to have already had that contact.

He contacted the recruiter later who sent him a link to apply for an internship position after which he had an interview where he was asked behavioral questions and then received an offer.

One student who did not intern but would be applying to internships in the subsequent semester, Y91, was also actively networking at career fairs. Y91 was a female student who was in freshman year,

Aman: Through a prior project, we have found that 20% of the students participate in internships in freshman and sophomore years. So, given that statement, are you applying for internships for the upcoming like summer?

Y91: I would like to apply for internships for the upcoming summer. I haven't yet.

Aman: And, I think maybe you mentioned that you have attended some career fairs, so have you already attended those or will you be attending the future?

Y91: I attended the fall career fair here, but, I did it mostly as networking because my resume doesn't have a lot on it yet. I went into the career fair and, as soon as I got there I saw the [Unity Ivy] and, they were super nice

> and I talked with them. And, I'm thinking about submitting an applications to them but, I haven't, yet. I went there, talked to them, shook the guys hand and he asked me about what I was interested in and, I asked him about his company and, he told me and, they gave me a T-shirt […]. And then, I went on to another booth and it was like the same, just shook their hand, talked to them about the company, they asked me what I was interested in and, looked at my resume. Then watch and repeat a couple more times.

Similarly, Y90, a student who was a sophomore and was involved in personal projects, tutoring and coursework, did not secure an internship yet but was actively networking at career fairs by volunteering for the career team which organized the career fair at their university,

> Career team [is …] a group of people who are volunteer for during the career fair season. Like helping set up, helping like tear down things, and like making sure the employees don't have a lot of trouble. […] I participate [in career club] mainly because I think it's a good networking opportunity, because they'll send everyone's resumes out to companies before the career starts, and if you're working during the day of the career fair because you are interacting with the employers and helping them set up, that's also an opportunity.

Y82 was another student, who was a male in freshman year and was planning to apply for internships in the future years and had a networking strategy,

> Aman: How are you preparing to get an internship?
>
> Y82: Yeah, so technically I'm starting right now for preparing for an internship. The way I'm doing it is I'm going in with the mindset that I'm not expecting to get any internship this year, but next year and the next-next year, I plan on getting an internship. The way I'm planning on doing it is that I'm planning on getting all my knowledge and all my resources and everything done this year and make sure I can network to many people so I can reach out and see, “Oh, hey,” and then go next year, after the next year, be like, “Oh, hey. Do you remember me from last year?” and then show an interest in the company,/ This will lead to more chances of at least getting a phone call in the first place, and then interviewing will be much easier.

14. Family referral (n=4, intern: 3, did not intern: 1)

Four students described that they leveraged family connections for referrals when trying to secure an internship. Of these four students, three secured an internship and one did not participate in an internship. For instance, P390 is a female student in her junior year secured her internship through family connections,

> Aman: Can you tell me the story of how you got your first internship at [anonymous large Fortune100 technology company's foreign office]?
>
> P390: I got it because one of my aunts works as human resources. She works in human resources at a military base in [anonymous country], and there was a seminar about finding a job after you retire from the military for military members. There was someone from [anonymous company] that was there, and she told that person about me. Then I reached out to him, and then he was able to help me find the right people to talk to. I was able to get an interview. Then from there I was hired. […] My internship wasn't a specific program because they don't really have those kinds of things. It was something that was special. You needed to have connections to get those special internships because all of the interns that worked there were from families that were super rich. One of the people that were interns was the son of the head manager of [anonymous company]. Then another person, he was the son of the [anonymous] division of the [large business advocacy group]. It was something like you just needed to know people to get into.

Similarly, P739, a female student in her junior year who participated in three internships stated that she secured her first internship in the company where her father used to work,

> Aman: Can you tell me the story of how did you get your first internship?
>
> P739: First internship definitely was just because my dad worked at this company. Even though my dad's not a software guy, there's a software department for them, and I think he was able to like, "Here's her resume, check it out." I don't think they usually have software interns, so it's not something they would post online or anything. I think this was one of their first times doing interns.

P223 is a male student in sophomore year who wasn't able to secure an internship although he planned to leverage family connections to secure one,

> Right now, I'm looking at some film production companies that I know through some family friends.

4.4.4.4 Key findings from strategies

Students who secured and participated in internships tended to apply earlier, typically in their freshman and sophomore years. They applied to many companies and proactively used a variety of strategies, such as attending conferences, networking, emailing recruiters, tailoring their resumes, strategically balancing coursework with internship preparation, and leveraging referrals. To clear behavioral or technical interviews, these students often followed a proactive approach by preparing before applying to companies. Conversely, students who did not participate in internships often applied later in their academic programs or were still developing their skills to apply in the future. Additionally, they tended to apply to fewer companies, prioritized coursework over internship seeking, and took a reactive approach to interview preparation - preparing only after receiving an interview invitation or, in some cases, not preparing at all. However, both students who participated in internships and those who did not were actively building skills, getting involved to demonstrate their qualifications to employers, and seeking guidance and support from mentors and professional connections.

4.4.4.5 Challenges

Students described 16 challenges that they faced or suggested other peers would face pertaining to career preparation or internship/job seeking (see Figure 4-11 and Table 4-16). These strategies were further abstracted into three themes: (1) socio-economic challenges, (2) psychological challenges, and (3) process and structural challenges.

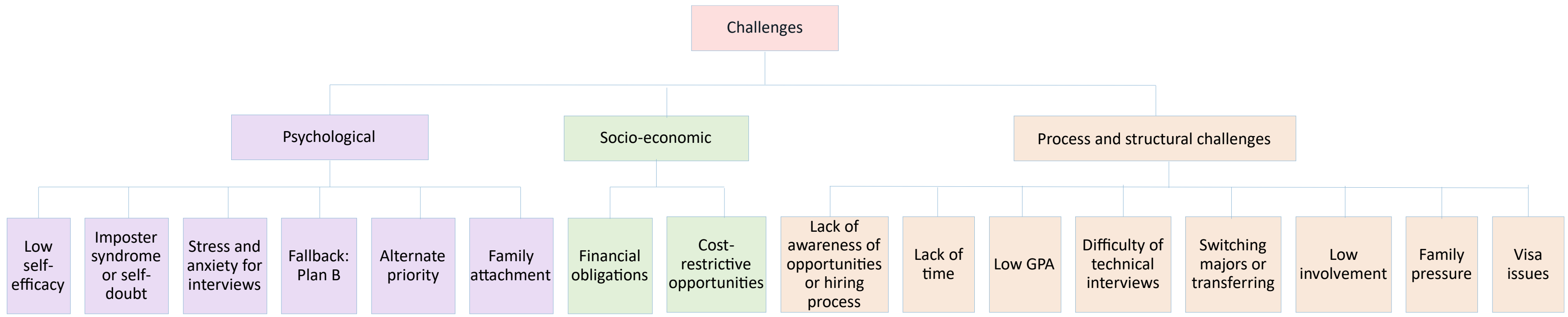


Figure 4-11. Challenges students faced pertaining to career preparation or internship seeking

Table 4-16. Challenges students faced pertaining to career preparation or internship seeking

Theme	Category	intern	did not intern
Psychological challenges	Low self-efficacy	7	16
	Imposter syndrome or self-doubt	10	4
	Stress and anxiety for interviews	3	4
	Alternate priority	0	5
	Fallback: Plan B	0	3
	Family attachment	0	1
Socio-economic challenges	Financial or family obligations	0	4
	Cost-prohibitive opportunities	3	0
Process and structural challenges	Lack of time	1	8
	Lack of awareness of opportunities or hiring process	5	3
	Switching majors or transferring	0	7
	Low involvement	1	6
	Low GPA	1	5
	Difficulty of technical interviews	4	1
	Family pressure	1	0
	Visa issues	0	1

Theme 1. Psychological challenges

In this theme, students described several psychological challenges they faced when trying to apply or prepare for the internship recruitment process. These challenges were categorized into six categories (see Figure 4-12).

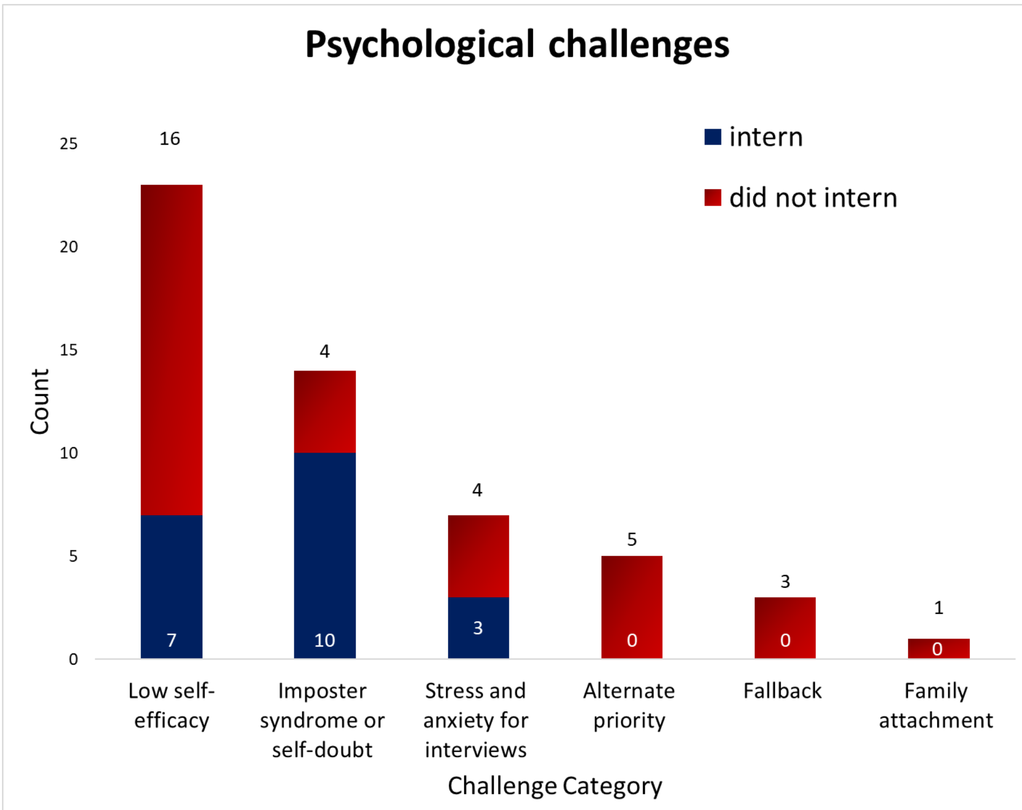


Figure 4-12: Psychological challenges students face pertaining to career preparation or internship/job seeking

1. Low self-efficacy (n=23, intern: 7, did not intern: 16)

In this category, 23 students described that they felt less confident in applying for jobs, succeeding in technical interviews or securing a job due to lack of technical skills or necessary preparation to clear the interviews. In addition, these students attributed their low confidence to a low GPA, challenging coursework, low involvement in activities outside the curriculum, failure in technical interviews, or having less experience when compared to their more experienced peers. 16 of these 23 students did not participate in internships and 7 students participated in an internship. For instance, P674 a male student in his super-senior year who transferred from another major and did not secure an internship stated that he failed to clear a technical interview due to less confidence in coding skills,

> P674: I think it's [failing technical interviews at small companies where he interviewed] because I didn't have that much experience with the technical coding, because I was still relatively new to coding at the time. And just my approach to coding, I'm not the most proficient. So that's one of the things I've wanted to work on, is my proficiency in coding, and being able to just be able to code very well.
>
> Aman: How confident are you in your skills that you're developing right now?
>
> P674: I would say mildly confident. Because I'm still learning and still, even though it's been almost two years of being in the computer science program, I feel like I'm not as proficient, as I would like, so I'm not as confident.

Similarly, P677, a female student in junior year, did not secure an internship and suggested that she failed in the process because,

> I think it was definitely my own skill, because like I said I haven't been prepared enough with studying for these technical questions. So, I could already see that I wasn't as proficient in answering or conveying my ideas as well either.

Another student, Y82 who was a male in freshman year and was planning to apply for internships in the future years applied to one company in the freshman year and stopped applying after receiving an email that he was not selected post an online application he filled,

> I wasn't confident enough to apply to any internships, but I did in fact apply to I think one internship, and then after that I didn't get in, so I didn't apply after that thinking I don't have the experience or don't have the knowledge to secure an internship.

Another student, P223, a male in sophomore year who did not apply to internships stated,

> I think my base coding skills are something that I can heavily improve upon. I'd say that's definitely something where I'm lagging behind. With some of my computer science peers, I think my base skills still need some improvement.

P223 decided to pursue studying abroad over an internship and when I asked him for the reason, he replied,

> Well, with pursuing an internship, I didn't feel like I had the experience or skills necessary to pursue a new internship.

P591 is a male in the sophomore year who is involved in clubs and personal projects. He applied to a few internships and failed to secure one. I asked him "*what skills [did he] think [he was] lacking, which [was] preventing [him] from getting an internship?",* to which he responded,

> I think it's definitely just the technical skills. My communication skills, I think, are there, my leadership skills are there, my people skills are there. It's just the technical skills. I can tell them I have these skills, I know how to do these things, but I feel like if I don't show them in a way, if I don't have projects or things to talk about, then I'm not as credible.

P690, a male student in senior year who had not participated in an internship, was not applying due to lack of confidence in technical skills although he had worked as a teaching assistant and in part time jobs related to data analytics,

> Not having the skills has been a challenge. It's very hard to apply for an internship, but I feel very adverse to applying to an internship when like I haven't learned Java or something. Particularly to me since I switched my major, like after my first year here, it was tough. I didn't want to apply any internships because I didn't even take a job of course at that point yet. And even then, like some of these data science or data analytics things, like just not having the skills to showcase. Like if you look at the requirements in these jobs, "It's like, "Ooh, I don't know if I fit any of that stuff? And it's definitely a challenge. I would say like that's the biggest challenge, just like skillset.

Seven students who were able to secure and participate in internships also described that they had low confidence at some point in their degree program or in general. For instance, P329, a male student in senior year, who participated in three internships stated,

> I started [looking for internships in] my freshman year as well, but I was scared of talking to big companies, just because I thought it was going to hinder me later on. But that's completely, obviously you should start talking to big companies like Google, Facebook, Apple, whatever, from the very beginning. [… I was] going to avoid talking to Google for like, two, three years because I'm not ready. I thought, when I talked to them, eventually down the line, I'll know how to code, I'll have projects, I'll have everything, and it'll be good. But that's the wrong approach, they have things for freshmen. I just, when you first started school, especially as a freshman, you just feel like, and you're talking to these companies. You just don't feel like you're ready or that they're going to care about you, I guess, in a sense. I just thought, obviously they're looking for the best and as a freshman, you're not the best. I kind of just said, “Let me try to become the best before I go and talk to them.”

Another student, P401, a female in her super-senior year who secured an internship due to her previous experience with graphic design very late into the program stated,

> I believe as a Computer Engineering student, I lack what most employers look for in potential engineering employees. I feel like my skills in programming are not up to par and that I barely touched the surface in what the hardware side has to offer for a CpE student. Most employers are looking for either a Software Engineer or an Electrical Engineer and I have some skills for both but not the strongest. […]

When I asked P401, why she felt less confident, she stated that it was because of her “not doing that well in classes like GPA-wise. Yes, [she is] passing, but it's not a 3.0. [She is] slightly below a 3.0”. Additionally, she commented that her “peers would be doing a lot better than [her] for sure [as she hasn’t] been pushing [herself] hard enough for outside projects, solo projects”.

P645, a female student in her super senior year who was involved in clubs and secured two internships through technical conferences also described similar feelings,

> The education was quite difficult and my experience as a black women was strenuous; My degree program is intense and extremely competitive because the people in it are pretty advance compared to me. […] I've had some bad experiences and I just feel maybe, I don't know. I just never feel smart enough or capable to do like computer science, It's like pretty difficult. I'm registered. I didn't really like feel like super confident and I still don't. That's why I just kind of at this point just trying to graduate.

2. Imposter syndrome or self-doubt (n=14, intern: 10, did not intern: 4)

Imposter syndrome is the feeling of self-doubt and inadequacy. People experiencing it often believe they don't deserve their achievements and fear being exposed as "fraud," even when they are competent. Some students described that they doubted their abilities or felt like an imposter in their computing major or when they were involved in extra-curricular activities that employers look for when hiring potential interns. Ten students who had participated in an internship and four students who did not participate expressed self-doubt or being an imposter. For instance, P591, a male in the sophomore year who did not participate in an internship expressed self-doubt after failure in initial internship seeking process,

> I did get a little bit disheartened, even though it was only a few [places I applied]. I thought if I couldn't even get this one, what makes me a good applicant for others. […] A lot of these students just put so much time into it. A lot of them do go to CTFs every week, they go to hackathons once or twice a month. I haven't done it, I feel like it's just been discouraging because these guys know so much. It is intimidating.

Similarly, P578 a female student in freshman year described her challenges in the program,

> Some problems seem impossible, so it is discouraging or how fast paced the program is and not being able to keep up could be discouraging and so I wonder if this is right for me.

On the contrary, students who interned also described similar feelings at an earlier point in the program and explained that participating in internships alleviated these feelings. For instance, P739, a female in her junior year who was involved in clubs, personal projects, explicit interview preparation, and participated in three internships stated,

> This is something I think I struggle with a lot, because there's a lot of really smart kids at Rose-Hulman, and I definitely feel like I'm not as smart. There's been tons of times that I'm like, “Oh dude, I shouldn't even be at Rose-Hulman. I probably can't do this, I don't think I'm smart enough,” kind of thing. Then I talk to people, and people tell me, “Oh, you'll be okay. It'll be fine,” sort of things. Then really, I just come back to, I do enjoy [CS], so I'm going to just do me, I guess. But I feel like other kids definitely seem to figure things out a lot quicker than me.

Similarly, P354, who was a female student in her senior year and wanted to pursue a Program Manager role in the future explained that she felt like an imposter during the internship interview process. She participated in five internships and encouraged others to explore career paths after a CS degree although the society amplifies software engineering jobs,

> And so [at FAANG company], it was halfway through my [first] internship and we had to decide like, “Do you want to be software development or program management?” But to be program management you had to do an additional interview. And then there was also, if you wanted to switch teams you had to do an additional interview. And I was really stressed about it because I could tell that I was being drawn to program management, but I felt like I needed to prove that I was a software developer first or else I was a fraud as a CS major. But then someone told me something that was really interesting and it was like, “If you want to be a baker or if you want to be a chef, I guess that doesn't matter, but if you want to be a chef, why would you become a baker?” Why not just build the skills of being a chef? And so in my mind I realize at the end of the day, I think I knew I wanted to do program management anyways. It was just a very prideful motivation that was pulling me towards being software developer. Eventually I realized I am not a fraud as a CS major. This is just a societal expectation.

Another student, P440, who was a male in junior year and secured two internships, experienced impostor syndrome while preparing for technical interviews,

> My third challenge [to secure an internship] was, there was kind of this mental barrier that I also had to get through. So, I realized that I was doing a lot of things, I tried picking up leadership positions on campus so that I can expose myself to more companies. I became a teaching assistant because I realized that I could use that reinforcements of concepts. But the mental barrier that I kind of had to get through was while I am trying to do all of these things, why is it that I'm not being rewarded with the types of jobs that I see other people kind of getting? So it was kind of an imposter syndrome kind of deal where I was like, "Do I really belong in this industry if there's all these other... If I'm not seeing the results coming out of all of the hard work that I'm putting into it." So getting over that was also a major barrier that I had to cross as well. So right now, I don't consider myself to have imposter syndrome anymore because I have seen the results in all the hard work that I have achieved so far.

P733, a female in senior year who was involved in personal projects and hackathons and participated in two internships described her feelings of being an imposter after receiving offers from two of the five largest US technology companies and clearing technical interviews (including seven interviews at one of those companies),

> When I applied to those 17 companies [during sophomore year for internships], I applied to both big companies and smaller companies where I thought I had more of a chance. I really only got responses back from the bigger ones. That was really weird to me. At the time, and sort of now, I thought it was because of my diversity, so to speak, because I am a black woman and that is fairly rare in the software community. I had a lot of, I don't know, kind of imposter syndrome style thoughts about getting those offers because it didn't feel like it was supposed... It just didn't feel right, if that makes sense.

Y89, a female student in junior year who participated in two internships also shared that she felt less confident and had feelings of imposter syndrome in the major,

> I don't know, a lot of the people that I hang out with I guess are super smart. Several of them had jobs after their freshman year, which I was looking at having an internship with Rockwell Collins and then that didn't work out because I had to go back home. I'm not an exceptional student.

> I'm very much like a B, C student. […] I feel like it's one of those things where nobody blasts their insecurities and shares those. They always try to pretend like they have everything together. […] So it's comparing yourself to other people, especially when you're at a school like Rose which is very, very hard. And I guess to some extent, I regret having chosen Rose only for this, since I feel like I'm a very small fish in a big pond. […] It very much feels like imposter syndrome because you look around and you feel like everybody else is like so successful and you're like, God, what am I doing with my life? Because I feel like average, and I realize if I had gone to another school, I'd probably be doing much better than I'm doing here in comparison to peers that I would have their versus peers that I would have here. I don't know it's hard to feel like you're special in any way when everyone's really smart and everyone's super special.

3. Stress and anxiety for interviews (n=7, intern: 3, did not intern: 4)

In this category, seven students described that they felt very stressed, nervous or anxious when preparing for or actually participating in behavioral and/or technical interviews. Four of these seven students did not secure an internship while three did participate in an internship. For instance, P354, a female student in senior year who pursued five technical internships shared that during her first internship's on-site interview at a FAANG company,

> I remember being very anxious and very stressed. There were behavioral questions and then there was coding questions. I think they asked me about palindromes.

P677, a female student in her junior year who did not intern yet stated that she faced the following challenge,

> Not being able to understand technical questions yet or being really anxious when during the interviews when we get to the technical part that I'm supposed to solve a problem but my mind goes blank because I'm just so anxious that all these people are waiting on me to figure this solution out, so that's one of the problems recently.

Similarly, P412 a male student in his super-senior year who did not secure an internship as he couldn’t clear technical interviews described the challenges he faced with technical interviews,

> I think definitely one of them was communicating with professionals, especially interviewers. I feel like the first interview I had last year with Facebook, I was just a really flustered and nervous, and I wasn't very confident.

Although P412 could not secure an internship, he secured a full-time offer after actively preparing for interviews following his failure in interviews for internships,

> I tried to have [confidence] this time for this company, [anonymous large software infrastructure company where he got the full-time job]. I feel like throughout the whole day I was interviewing there because it was like four interviews. I just felt I just had that confidence, and I try to be really lively in conversations. So, I think that one of the things that was holding me back was being able to stay confident and just express yourself in an impressive way.

4. Alternate priority (n=5, intern: 0, did not intern: 5)

In this category, five students described that they were not applying or were not securing internships due to alternate priorities such as participating in study abroad (n=3), pursuing sporting activities (n=1), or hobbies (n=1). All of these five students did not secure an internship. For instance, P692 a female student in freshman year (sophomore at the time of the interview) stated that she did not apply to internships in her freshman year as she wanted to pursue “*study abroad the summer after [her] first year”.* She *“wanted to study abroad because [she] loves traveling, and [she also felt] that studying abroad [was] only an opportunity that [one] can have while [they are] in college”.* She continued that

> You're going to have your whole life to work, so for me, it's like, take the opportunities that you have now to travel and see the world, do things that you're actually passionate about while you still can, before you get out into the real world.

Similarly, P591 a male student in the sophomore year who wanted to open a taekwondo school after graduation and work part time in cybersecurity found it hard to get an internship,

> My success isn't probably where I want it to be right now. I know that being at UF, you just have to put in a lot of effort. That means going to hackathons, that means making projects a lot. For me, it's just been harder to do that because of this idea that I want to do cyber security, but I also want to do Taekwondo. I haven't been fully committed, but I know that to be successful, you need to be fully committed. I've been thinking about that.

P677, a female student in her junior year who did not intern stated focused more on hobbies and coursework during the first two years of her curriculum and hence couldn't secure an internship,

> It's definitely because I didn't start early enough in preparation, because a lot of people are already pursuing an internship their sophomore year or as I did not pursue anything, I just sort of went through coursework and pursued my personal hobbies. And then it was the start of this semester that I actually started prepping for the internship.

5. Fallback: Plan B (n=3, intern: 0, did not intern: 3)

In this category, three students who did not participate in internships described that having an existing part-time job or an alternative career option led them to not aggressively applying for internships. For instance, P690, a male student in senior year who had not participated in an internship, was not applying due to lack of confidence in technical skills and having a fallback part time job related to data analytics and a teaching assistant position,

> Aman: Why do you think you haven't been able to secure an internship so far?
>
> P690: It's definitely more of my lack of effort in applying for these internships and things like that. I had the TA job, so I was guaranteed to work in the summer. So I felt like maybe that was a security blanket where I was like, "Oh, well I don't need like an internship when like that's not

> actually the case." So, a lot of it I would say is up to me, like not pursuing internships as much.

P591, a male in sophomore year, described that he had an alternate career option to be an Instructor at a Taekwondo school,

> Aman: Through prior research, we have found that 40% of the students actually intern before they leave college. Why do you think you haven't been able to secure an internship so far?
>
> P591: I've applied to a couple. I just think it's very competitive or maybe the ones I've been applying to have just been very competitive. Sometimes, I think that the fact I am interested in something else like Taekwondo will set me aside from other people, but I know that it also hinders me because I don't have as much technical skills as other do. I know they've put the time into that, so that's why I feel I haven't been able to secure one. Because I haven't been fully committed to developing my technical skills.
>
> Aman: What do you think will make you put more time into developing your tech skills?
>
> P591: It's just the mental thing. I just have to tell myself, "You have to start doing projects. You have to start reading more. You have to really start putting the time into online courses and reading to start developing those tech skills."
>
> Aman: Do you think, since you are pretty proficient at Taekwondo, this is hindering you from putting all your energy into developing tech skills? Like you have a safe space in the back of your mind.
>
> P591: Yeah. I think, yeah.

6. Family attachment (n=1, intern: 0, did not intern: 1)

In this category, one student, P591, a male in sophomore year, described that he was fearful of applying for internships in other states as they didn't prefer to go away from their near ones if they were to participate in an internship,

> Aman: What are some of the challenges that you have faced so far in getting an internship?
>
> P591: One of them is probably leaving. I know a lot of internships are out of state or somewhere else. It's just an internal thing where I don't know if I'm ready to actually be by myself, even if it's only for two months. That's

> just an internal thing. That's a big one. That's probably something that discourages me from applying to internships that aren't local.[…] I just think I'm scared of living by myself.

Theme 2. Socio-economic challenges

In this theme, students described the socio-economic challenges they faced when trying to apply or prepare for the internship recruitment process. These challenges were categorized into two categories (see Figure 4-13).

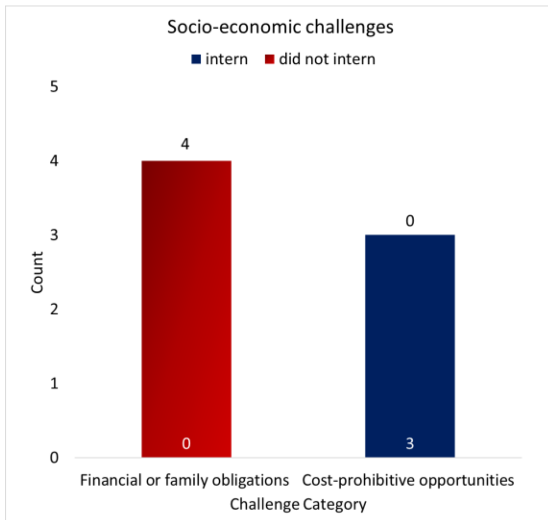


Figure 4-13: Socio-economic challenges students face pertaining to career preparation or internship seeking

7. Financial or family obligations (n=4, intern: 0, did not intern: 4)

In this category, four students stated they worked part-time and hence were either less involved in extracurricular activities or in the preparation process of securing an internship. All of these students did not participate in internships and one student had to decline an offer due to financial reasons. For instance, P785, a female student in her senior year who transferred from a community college felt a steep drop in her GPA and suggested that this drop was due to her juggling part-time work for financial reasons. She then had to focus on courses rather than seeking internships,

> P785: I feel like transitioning to [the university] from [anonymous community college] was tough. So just adapting to choosing a new system was complicated. […] I was always near the very top class student [in the community college], and that also affected me emotionally, not doing well and stuff, which also creates kind of a cycle that you feel that because you're not doing great, and since you feel bad, it hard to do great. I was working 20 hours a week working on Starbucks, and then I was also working on that start-up. And I was taking training, and I was taking 14-credit term.
>
> Aman: And was this working in a part-time job just because of financial reasons, or was it more like you wanted to gain some exposure?
>
> P785: More for financial.

Similarly, P315 a male student in senior year did not secure an internship as he was a transfer student as wasn't much involved due to a low GPA and had to work part time to support himself,

> I've been working since I basically started school. So, I don't have that much time left to work on projects or do anything much. Or do much else outside of my coursework. So that's one of the things I'm kind of afraid, that it's going to be kind of difficult for me to find work right after college. […] First my financial situation, just having to work a lot of hours a week to help maintain myself during college. That has taken a toll on me, physically and mentally, since I can't really work as much as I would like in my studies. But, also just the long hours that I have to work, both school and work, it's tiring.

P600, a female student in senior year in the online CS program secured an internship but couldn't pursue it due to financial and family obligations,

> 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. […] I was offered an internship at WellCare Health Insurance over in Tampa. Their offer letter was just not at all in the same ballpark as like American Express or Microsoft or Facebook or any of those guys. So I declined to them because it would have been a financially poor decision for me to go over there.

P600 shared that as a mother and online student she didn’t have time akin to a campus student for interview preparation,

> I'm in a very unique situation where I don't have all of the free time to dedicate to code and interviewing practice and all that kind of stuff. Our son was born in February of 2017 and I started January of 2018 at UF Online for the computer science degree program. And so, I was taking care of an almost one year old, up to two years. I stayed at home watching him. I didn't get to put him in daycare and then have all the free time. I was just trying to complete stuff while also watching him. Yeah, it's very different when you don't have as much free time to dedicate to the side projects or personal projects, the interview prep, the LeetCode, all that stuff.

8. Cost-prohibitive opportunities (n=3, intern: 3, did not intern: 0)

In this category, three students who had both participated in internships described that they secured internships through technical conferences such as SHPE, Gracehopper Celebration of Women, etc. and spent money to attend these conferences. These students explained that not all students in their respective clubs could go to these conferences as they are expensive.

For instance, P329, a male student in his senior year who participated in three internships, all secured through the SHPE conference stated, “*Not all of [students in the organization] go [to the conference], because it's expensive*”. Similarly, P666, a male student in junior year, secured his first internship in air force by applying online where he was selected without an interview. He secured his second internship via the SHPE conference which his friend recommended to him,

> I am not Hispanic at all but one of my really good friends is and he was like, “Hey come on, you're not Hispanic but you're going to this. It's expensive but trust me it's worth it.” And I was like, “Okay”.

Theme 3. Process and structural challenges

In this final theme, students described challenges pertaining to the interview or application process as well as other structural challenges that hindered their ability to participate in an internship or the recruitment process at large. These challenges were categorized into eight categories (see Figure 4-14).

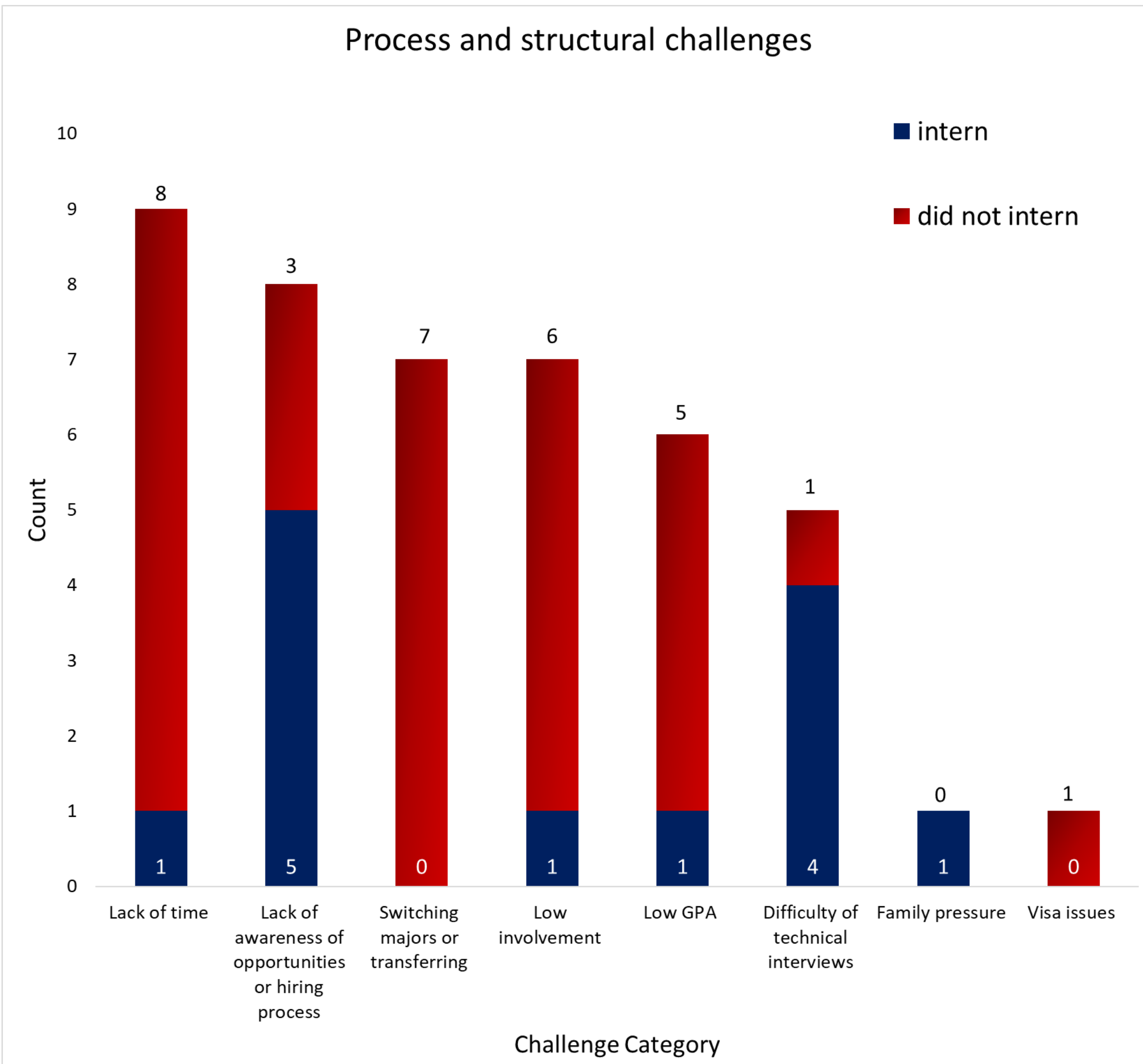


Figure 4-14: Process and structural challenges students face pertaining to career preparation or internship/job seeking

9. Lack of time (n=9, intern: 1, did not intern: 8)

In this category, nine students described that they had no time to get involved in external involvement activities such as personal projects, clubs, hackathons, etc. or prepare for interviews as they were dealing with extensive coursework and other responsibilities such as family or work. Eight of these students did not participate in an internship and one student participated in an internship. For instance, P674, a student in super-senior in the program who worked part time advised future students to read the Cracking the Coding interview book participate in mock interview workshops, and practice technical interviews. However, he himself, hadn't *"had time to get all of that done by"* and he was "*not participating in personal projects, or technical CS clubs"* due to "*a lack of time"* which he was "*starting to pick up more"* at the time of the interview.

Another student, P690, a male in senior year who had not participated in an internship and was pursuing a part time job related to data analytics as well as worked as a teaching assistant stated that he wasn't involved in clubs, personal projects, explicit interview preparation and had attended one hackathon.

> Aman: How are you preparing to get an internship?
>
> P690: Just like keep on doing my classes, keep on working hard in my jobs and things like that. I'm not really doing anything outside of that right now.

10. Lack of awareness of opportunities or hiring process expectations (n=8, intern: 5, did not intern: 3)

In this category, eight students described that they were unaware of internship opportunities especially for specific computing area internships such as ones in cybersecurity or opportunities that were catered to students early in their programs such as freshmen or sophomores. Students also said that they were unsure of the roles that a company offers and what those roles entail. Additionally, they were also unaware of the employer expectations from candidates regarding the hiring process. Students who secured internships also reported being unaware of early internship programs meant for freshman and sophomore at top tech companies. Three of these eight students did not secure an internship while five did participate in an internship. For instance, P674 a male student in super-senior year interested in a career in computer networking, and he did not secure an internship discussed,

> Aman: When you applied to these internships, or full-time roles, what kind of roles were they? Were they more related to networking or software engineering?
>
> P674: They were more software engineering.
>
> Aman: And why is that? Because you thought your career trajectory would be more towards the networks, right?
>
> P674: At the time I was applying, most of the jobs that were presented or that I could find, they were more software base. So, I didn't really finding too many network ones at the time.
>
> Aman: But did you try to reach out to your coworkers here at [anonymous organization where he works part-time in a networking job], and ask them maybe what kind of jobs are available for network engineers in industry or internships?
>
> P674: No, I don't remember asking.
>
> Aman: And do you know why?
>
> P674: Yeah, I think it just never crossed my mind to ask.

Similarly, P591 is a male in the sophomore year was unaware of cybersecurity related internships as he was primarily interested in that area but was primarily applying to software engineering intern positions,

> The [positions] that I've seen the most is software development, so I'll just have to learn to like it. I've been looking for cyber security internships, but they're harder to find. Then the other, what I've been saying is they also

> require more experience. […] I find it hard to find a company that will give me an internship in something I am interested in such as cybersecurity.

A student who had participated in three internships, P739 who was a female in her junior year also shared similar challenges prior to securing her first internship,

> I guess maybe just discovering what sorts of jobs are out there and figuring out what steps I need to do to, like, get the skills to be able to do those specific jobs.

She actively attended career fairs and company information sessions to get awareness of the opportunities.

Another student who secured one internship through family connections and did some practice for subsequent internships but couldn’t clear technical interviews, P390, a female in junior year, recalled about why she failed in technical interviews,

> I think maybe I wasn't too prepared for technical questions because at that time I didn't really realize I had to study for interviews.

11. Switching majors or transferring (n=7, intern: 0, did not intern: 7)

In this category, seven students who did not intern described challenges associated with coursework that happened after they switched majors late into the program or transitioned from community college to university. These students often describe that the college they came from after an associate degree often had lower academic standards and easier courses. Additionally, they started applying for internships very late into the programs due to this transition. For instance, P785, a female student in her senior year who transferred from a community college had a steep drop in her GPA and expressed how this impacted her emotionally,

> I feel like transitioning to University of Florida (UF) from [anonymous community college] was hard. I had a tough first year at UF. So just adapting to choosing a new system was complicated. […] I was always near the very top class student [in the community college], and that also affected me emotionally, not doing well and stuff, which also creates kind

> of a cycle that you feel that because you're not doing great, and since you feel bad, it hard to do great.

P315, a male student in senior year, did not secure an internship as he was a transfer student and attributed a low GPA due to the transition causing him to not secure an internship,

> As a transfer student, I just get 2 years at UF and my first summer I stayed on campus to take classes, and this summer I didn't manage to get an internship. […] When I transferred, it took a toll on me mentally because I was the first time away from home and I don't know what's different, trying to adapt. That first year here at UF was rough for me and that took a toll on me, both mentally and my GPA. And after that it's really been hard to recover my GPA. And like I said, keeping up it's been rough.

Similarly, P412, a male student in his super-senior year couldn’t secure an internship as he applied late for internships due to him switching majors,

> I switched majors a lot during my first two years here, and I wasn't in Computer Engineering until halfway through my sophomore year.

12. Low involvement (n=7, intern: 1, did not intern: 6)

In this category, seven students described that they had a low involvement in extracurricular activities which would impact their ability to secure an internship as employers look for involvement outside of coursework or they started getting involved outside the curriculum very late into the program. Six of these seven students did not secure an internship while one student did participate in an internship albeit low external involvement. For instance, P315, a male student in senior year who did not secure an internship shared what he thought attributed to him not securing one,

> I think it's because of my grades and I talked with different recruiters, most of them wanted a good GPA, which I don't have or me participate in like hackathons and that kinda stuff, which I really haven't done. And I think that, like I said, that experience factor, it's what other satisfactory factor in the selection process.

Similarly, P382, a female student in her super-senior year did not secure an internship due to low involvement in personal projects,

> Aman: Through prior research we have found that 40% of seniors, and super seniors pursue an internship. So why do you think you haven't been able to secure an internship so far?
>
> P382: Because I don't have any personal projects done, but I am working on it. And at my year now, I should probably have like two, or three personal projects done.

P645, a female in super senior year who secured two internships shared why she failed in her initial years when applying for internships,

> I wasn't involved in anything, so I had nothing to offer. My resume, from what I remember, it was still stuff from high school. So, nothing really. And I also wasn't really taking any Computer Science courses in my freshman year, until like later. I really didn't have the technical skills so there was nothing for me to offer.

She was later on able to secure internships due to her involvement in the National Society of Black Engineers (NSBE) leadership and attending NSBE conferences.

13. Low GPA (n=6, intern: 1, did not intern: 5)

In this category, six students described that they had a low GPA and had to prioritize coursework over applying for internships or preparing for interviews. Five of these six students did not secure an internship while one student did participate in an internship. For instance, P382, a female student in her super-senior year who was a transfer student and did not secure an internship, attributed her "*lack [of] skills and personal projects [and her] GPA isn't the best either, as most engineering students GPA average to a 3.0"* to not having secured an internship.

Another student, P315, a male in senior year who did not secure an internship shared his challenges,

> Well, my grades are not that great. I've been struggling a lot with my classes lately and, I don't know, it's become more difficult to keep up the way I would like to be. I feel like I am not as prepared as a lot of people. A lot of people get internships. I couldn't get any. So that's another thing that's kind of hanging in the back of my head. Not having any type of experience before I graduate.

One student, P401, a female in super-senior year was able to secured an internship in her final year. She attributed her previous lack of applications to internships to her having "*participated in one career showcase [career fair] and [her] current GPA [being] not pleasing"*.

14. Difficulty of technical interviews (n=5, intern: 4, did not intern: 1)

In this category, five students described the challenges they faced with technical interview questions suggesting that they had a hard time understanding the technical interview questions and would often struggle with them. Four of these five students secured an internship while one student did not participate in an internship. For instance, P645, a female student in super senior year who participated in two internships which she secured through technical conferences stated,

> I was really struggling with technical interviews a lot and I just realized like why am I doing this? If it's not good, if I can't do it. Clearly it's not for me. So just things like that. And then focusing more on the energy towards the role that I know do fit me and doing those researches on like that.

She switched into looking for program management roles rather than software engineering internships after finding these technical interview questions challenging.

Another student, P329 a male in senior year who participated in three internships related to software engineering roles secured the internships through a technical conference where he was asked primarily behavioral questions during interviews suggested, P329: Definitely technical interviews are really hard. That's definitely, they're hard. I've had a lot of interviews with Google, Microsoft, Facebook, whatever, and they always get me.

Aman: What are some of the challenges that you have faced regarding the technical interviews?

P329: I think it's time constraint for sure. I feel like 45 minutes, the idea sometimes is, they give you a very complicated problem that you can barely finish in 45 minutes, give or take. I feel like I, maybe the way that I think about code and write code, doesn't really do well in the interview format.

P677, a female in her junior year who did not intern yet stated that the challenges she faced with technical interview questions,

Not being able to understand technical questions yet or being really anxious when during the interviews when we get to the technical part that I'm supposed to solve a problem but my mind goes blank because I'm just so anxious that all these people are waiting on me to figure this solution out, so that's one of the problems recently.

15. Family pressure (n=1, intern: 1, did not intern: 0)

In this category, one student described issues pertaining to pressure from their family to graduate early which led them to deemphasize internship participation. However, the student was able to secure an internship through a family connection. P390 a female student in junior year who participated in one internship described,

My family […] put a lot of pressure on me. So I feel like I have to do so much, and sometimes I get kind of overwhelmed. My parents are already kind of upset that I didn't graduate in three years, and I was like, “That's impossible.” They don't realize it, but they just keep bugging me about it. Sometimes it just feels like I'm taking on too much just to meet their expectations. […] I applied to a couple internships, but I decided to take summer classes because back to the whole pressure thing from my parents, they really want me to graduate in four years. So I needed to take a couple more credits to make sure I can graduate on time, so I just decided to stay for the summer and take a few more classes. […] I think maybe I would go back, and just for this summer and last summer I feel like I really could've just done an internship rather than just taking classes.

16. Visa issues (n=1, intern: 0, did not intern: 1)

In this category, one student who did not participate in an internship described visa restrictions on international students that prohibit them from working for any employer. P785, a female student in her senior year who transferred from a community college shared,

> Being an international student makes acquiring an internship a little bit more complicated than for American students. So it was a combination of not having the greatest GPA in my first year at UF, and also being a international student, which makes that a little bit more competitive. […]

She applied to both local companies and more established companies which were interested in sponsoring visas for full-time roles, but not for internships.

> These local companies, they gave me positive... but they always said like, “Call us when you're graduating.” And then, the big companies, once they knew that I was international, they were like, “Oh, no. Yeah, sorry.”

4.4.4.6 Key findings from challenges

Both students who participated in internships and those who did not faced a variety of psychological, socio-economic, process, and structural challenges. Specifically, students who did not participate in internships often exhibited low self-efficacy, prioritized alternate pursuits such as hobbies or studying abroad, or relied on a fallback plan (Plan B). Financial or family obligations sometimes prevented them from applying for or participating in internships, and a lack of time was also a common barrier. Additionally, some students cited difficulties related to switching majors, transferring from community colleges, low involvement in extracurricular activities, poor GPA, or visa restrictions.

Students who did participate in internships also reported experiencing low confidence and imposter syndrome, and many recalled that technical interviews were particularly challenging. Both groups - those who participated in internships and those who did not - expressed feelings of stress and anxiety about technical and behavioral interviews. Many also described a lack of awareness about available opportunities and the expectations of the hiring process.

4.4.4.7 Personas – students who secured internship(s)

Students who participated in internships (n=20) were categorized into five types of personas based on the strategies they used when approaching the internship recruitment process. Additionally, their attributes and strategies were taken into account when segmenting these students.

1. Driven Billie (n=8) - interned

Participants: P152, P354, P679, P733, P736, P739, Y70, Y86

These students proactively prepared and applied for internships, often securing and participating in multiple internships at companies such as Visa, Disney, Microsoft, JP Morgan, American Express, etc. They applied early, targeted many companies, engaged in mentorship from seniors, peers, or industry professionals, and pursued some explicit technical or behavioral interview preparation before securing interviews. While they initially faced rejections initially during the recruitment process, their resilience led them to persist, refine their skills, and ultimately secure opportunities. Despite their high agency and success, they found technical interviews challenging and stressful, experienced imposter syndrome, struggled to find time to balance coursework with interview preparation or extracurricular involvement, and exhibited low self-efficacy earlier in their degree programs especially prior to securing an internship. Four of the eight students in this persona were male, and four were female, spanning all five years of their academic programs.

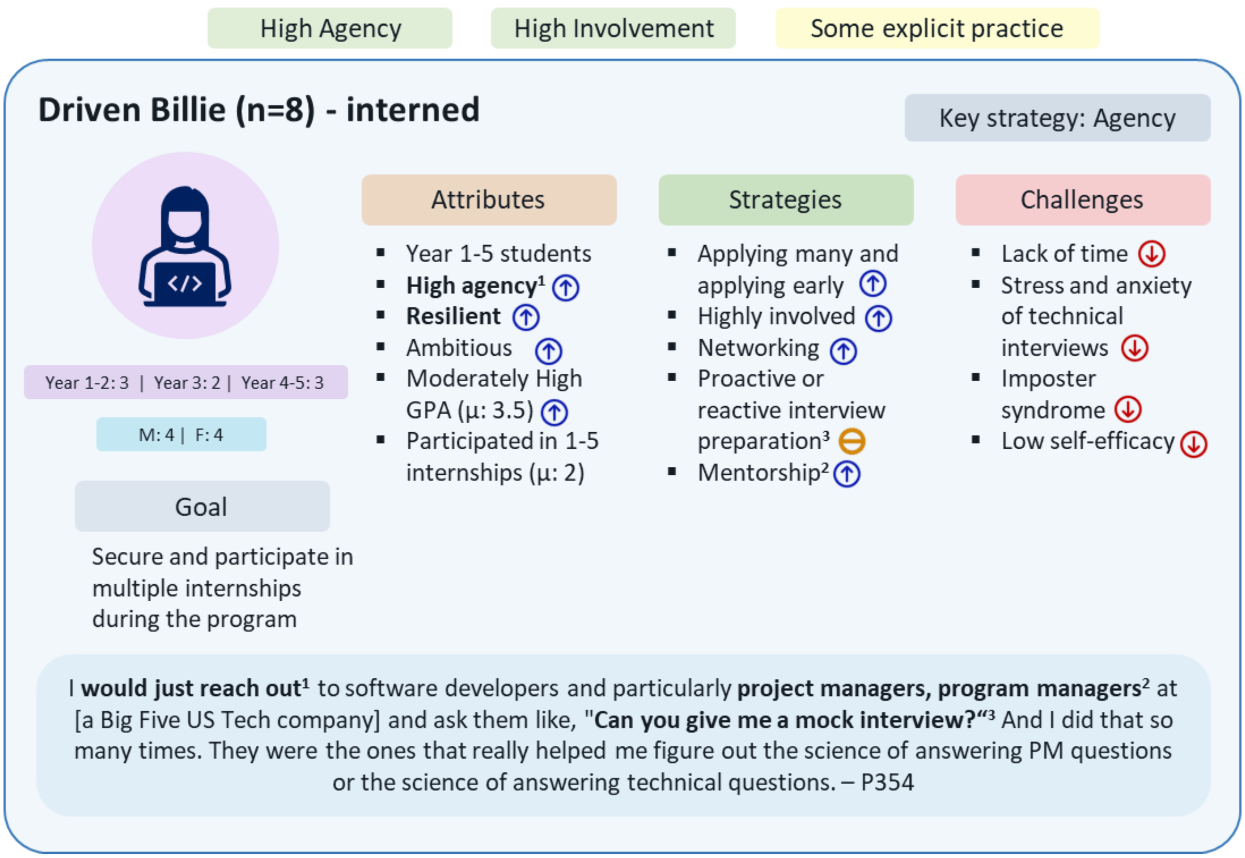


Figure 4-15. Persona describing Driven Billie (n=8), a student who interned

One example of a student who belonged to this persona is P354, a female student in the senior year who interned five times. P354 was proactively working on navigating professional opportunities and secured internships via networking and tips she received through mentorship at career fairs, club events and conferences. She started applying early and to many companies, but she failed several times in the application process before securing one due to her strong resilience, growth mindset attitude, and explicit behavioral and technical interview preparation. She shared how she got her first internship at a Big Five US Technology company in a program meant for freshman and sophomores,

> The first one I ever got. It wasn't the first interview I did. I've **definitely failed a lot of interviews**. I think it **started my freshman year**. So as soon as I got to college, I immediately started pursuing professional development opportunities. So, working on my leadership skills, working on my resume, working on leading things. I remember I heard of career showcase because I took a tour from the engineering ambassadors full circle. And they were like, "Go to career showcase even if you're a freshman, even if you feel like you don't have anything, just try it and learn." So, I went and I remember I went up to [Big five US tech company] having done no research, because I was naive and a freshman, and I went up and I was like, "I know you guys don't have internships for freshmen or sophomore but I just wanted to say hi." And the recruiter looked at me and she was like, "Yeah, we actually do so maybe come back next year." And I was like, "Oh no, I'm so sorry."
>
> So then next year came and I think they changed the recruiters miraculously or something. I was **determined to try again** because I was like, "That was a massive failure. I need to like throw good vibes into that failure and bring balance back to the world or something." And I was prepping and I did interviews. I did interview with [large industrial company], but I didn't get it that freshman year. So it was like really pushing to learn, like get interviews, resume, etc., learn and get mentors. Mentors is a big thing. I had a lot of mentors in different organizations, whether it was alumni mentors or career mentors.
>
> And then sophomore year came around, same time of your career showcase. And at the time I joined [a student organization teaching coding] essentials and I met this lady or this girl who's the president or something. I remember I came up to her and again I was just **adamant on learning and I went up to her** and I was like, "Hey, this program sounds really cool because it's education and I want to give back while also building my technical skills." It was like a beautiful combination and they needed a social media chair and I was like, "Hey, I'll do it". And then I guess [the president], I don't know what she saw in me, but she was like, "Hey I worked at [Big five US tech company], do you want a **referral**?" And I was like, "Yes." So she gave me a referral, which then I guess put my... I think the rumor is that it pushes your resume up to be seen. […]

After the referral, she got a phone interview invitation which she described that it "*somehow went really, really well*". The phone interview was "*very, behavioral and understanding how your mind thinks and understanding your passions for technology*".

Then the company asked her to fly out to the headquarters where she was asked to participate in 3-4 interviews which were a mix of technical and behavioral interviews. She described the interviews as,

> Definitely [the interviews at a Big Five US Tech company] wasn't anything intense, but I definitely **got coding questions**. I remember being very **anxious** and **very stressed**. It was a mix. There were behavioral questions and then there was coding questions. I think they asked me about palindromes.

She received her subsequent internship offers through conferences,

> Yeah, the subsequent ones were, they were really lucky and they were through conferences.

2. Resourceful Alex (n=6) - interned

Participants: P329, P351, P390, P645, P665, P666

These students applied for internships strategically at conferences often securing and participating in multiple internships which required them to clear only behavioral interviews or technical interviews with a low bar for passing. Prominent conferences where students secured jobs included the Grace Hopper Celebration (GHC) of Women in Computing, the Society of Women Engineers (SWE) conference, the National Society of Black Engineers (NSBE) Convention and the Society of Hispanic Professional Engineers (SHPE) Convention. Additionally, these students leveraged networking with connections or sought referrals from family or others in their network to secure an internship. These students applied early, targeted many companies, attended conferences multiple times, and pursued either reactive interview preparation after securing interviews or did not prepare to succeed in technical or behavioral interviews. Some of these students showed high agency but most students were resilient to continue looking for internships after initial failures. These students also found technical interviews challenging and stressful if they had to participate in one, exhibited low self-efficacy, reported lack of time for interview preparation or extracurricular involvement, and suggested that conferences are expensive to attend but worth it. Three of the six students in this persona were male, and three were female and all of these students were juniors or seniors. Five of the six students identified as belonging to an underrepresented racial or gender group.

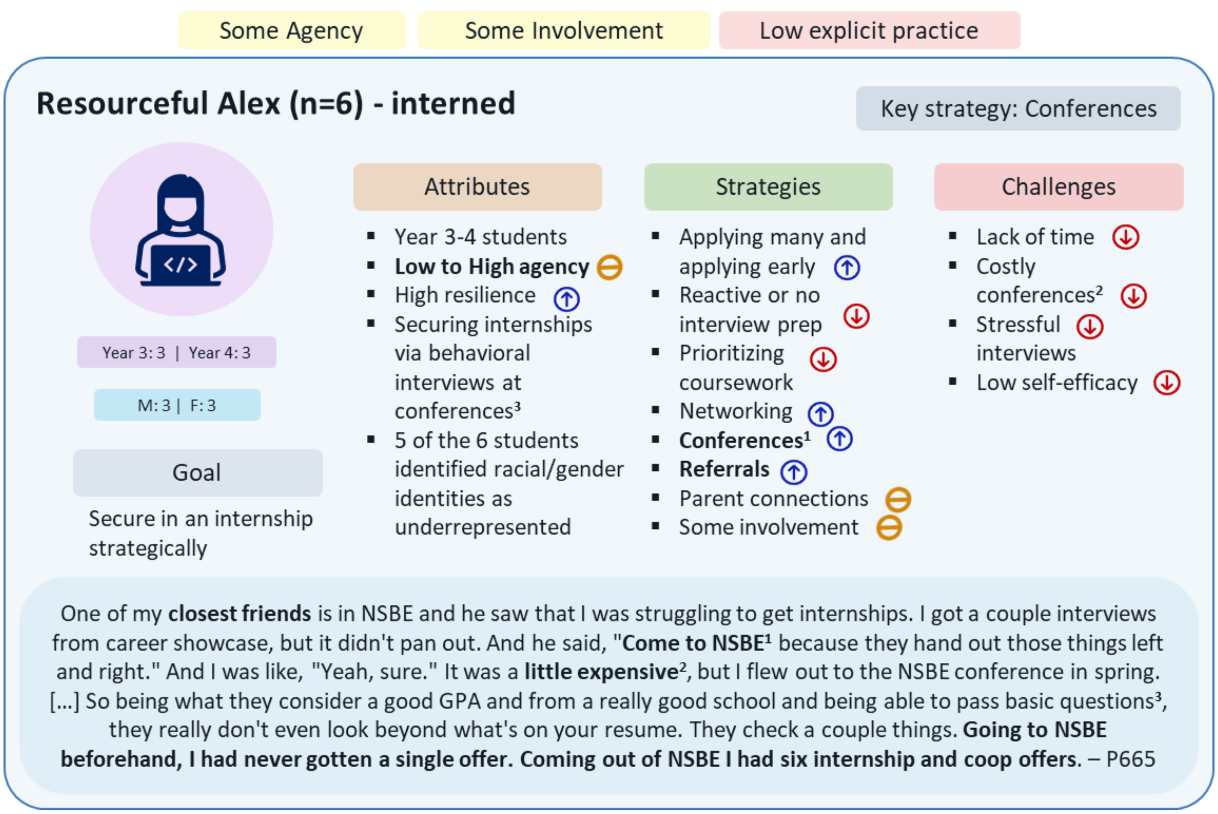


Figure 4-16. Persona describing Resourceful Alex (n=6), a student who interned

An example of a student belonging to this persona is P665, a male student who was in senior year who was involved in clubs and hackathons and attended conferences but did not pursue personal projects due to lack of time. He shared how he started applying as early as sophomore year, and was facing difficulties securing an internship at the university in sophomore and junior year,

> Freshman year, I didn't start computer science until my second semester. So I was not even in a position to think about an internship. So my second year I applied. But yeah, I would get a couple interviews, and I would get to the final stages, but they just wanted someone with more experience or someone with outside projects.

Then, his friend told him about the NSBE conference where he was able to secure many offers for an internship for the summer of his junior year,

> One of my closest friends is in NSBE and he saw that I was struggling to get internships. I got a couple interviews from career showcase [career fair at university], but it didn't pan out. And he said, "Come to NSBE because they hand out those things left and right." And I was like, "Yeah, sure." It was a **little expensive**, but I flew out to the NSBE conference in spring, and so there you're competing with kids from all other schools. And being from UF, we're number seven in the country and all that. People really like us. And my GPA was like a 3.46. Which, I didn't think was great, but they liked it. So being what they consider a good GPA and from a really good school and being able to pass basic questions, they really don't even look beyond what's on your resume. They check a couple things. **Going to NSBE beforehand, I had never gotten a single offer. Coming out of NSBE I had six internship and coop offers.**
>
> Yeah. It was really a blessing to go there. That might have been one of my only ways I could have gotten it. When I came back and I had [large fintech company] internship on my resume, then companies started actually responding to me. So it was kind of like I went full circle.

P665 shared that the bar for interviews is lower at these conferences and a lot of the employers ask behavioral questions,

> **So the [large fintech company interview – where he interned] one was supposed to be technical, but they messed up and both rounds were behavioral**, which is another reason I kind of got it, because it was really easy. One of them was like a LeetCode you could say. He just asked me to code, write code. One of them was more like problem solving, just think about it. **But those conferences are notorious for having easier than average interviews in terms of maybe they'll ask you to iterate through a string and find all the vowels or something** […]. So yeah. It was easier.
>
> So the one with [company 2 – tech internship in airlines] was like he asked me one question, and I actually got it wrong. He asked me the question in line and I got it wrong. But he still was interested, so I came back the next day for a behavioral and I told them the solution. One of the companies was [company 3 – tech consulting], so it was consulting. So it was purely behavioral. One of them was [company 4 – tech internship in a large

> bank], and theirs was a little more technical. It was like, "How would you design an app?" But not coding, just like screens and whatnot, and they just wanted to see your thought process. It was mostly they wanted to see your thought process. Yeah, I can't remember all of them. **But they're all pretty easy**, yeah.

3. All-in Haku (n=3) - interned

Participants: P440, P794, P900

These students applied early for internships at top companies in the technology sector aiming to secure one at the Big Five US technology companies: Alphabet, Amazon, Apple, Meta, and Microsoft. All three students who shared this persona secured and participated in one or multiple of the Big Five companies after several stringent technical interviews. These students were ambitious, had strong self-regulation skills, had high agency for proactive structure interview preparation and were heavily involved in activities outside of coursework. They would often deprioritize coursework to ensure they have a decent GPA but use the spare time to prepare for the employment recruitment process, pursue personal projects or other extra-curricular activities. All of these students also prepared for interviews both independently and collaboratively practicing mock technical interviews. These students also found technical interviews challenging and stressful and described feelings of imposter syndrome. All three of these students were male and were juniors or seniors.

One example of a student who embodied this persona was P440, a male student in the senior year who interned twice. P440 had a high GPA and was proactively involved in clubs, hackathons, and personal projects. He stated that he was preparing to secure an internship by polishing his resume to land interviews, working in leadership positions in clubs to network with recruiters, and independently solving Leetcode problems,

> There's two kind of major skills that I've been focusing on for the past year. And I think that's what a lot of recruiters are also looking for right now. But the way I've kind of sectioned it out is I've set to one milestone and that milestone is kind of divided between the first part of it is **getting ramped up, making your resume, bucking up your resume with a whole bunch of different technologies** because it generalizes it for all of the recruiters. So I think my **first skill that I wanted to build was being able to generate a breadth of knowledge** within there. So right now, if you look at my resume, for example, I try **to put in as many buzzwords** as I can so that it just engages some recruiter at some point in time. And so that's what I kind of focused on before.
>
> And then right after, I realize that I had enough content on my resume for it to be looked at by a recruiter and kind of pass me over to the interviewing phase. I **started focusing on data structures and algorithms**. So that was entirely focused on **doing LeetCode questions** and pairing up with my friends and working with each other to keep each other accountable to solve more problems and being able to interview better.

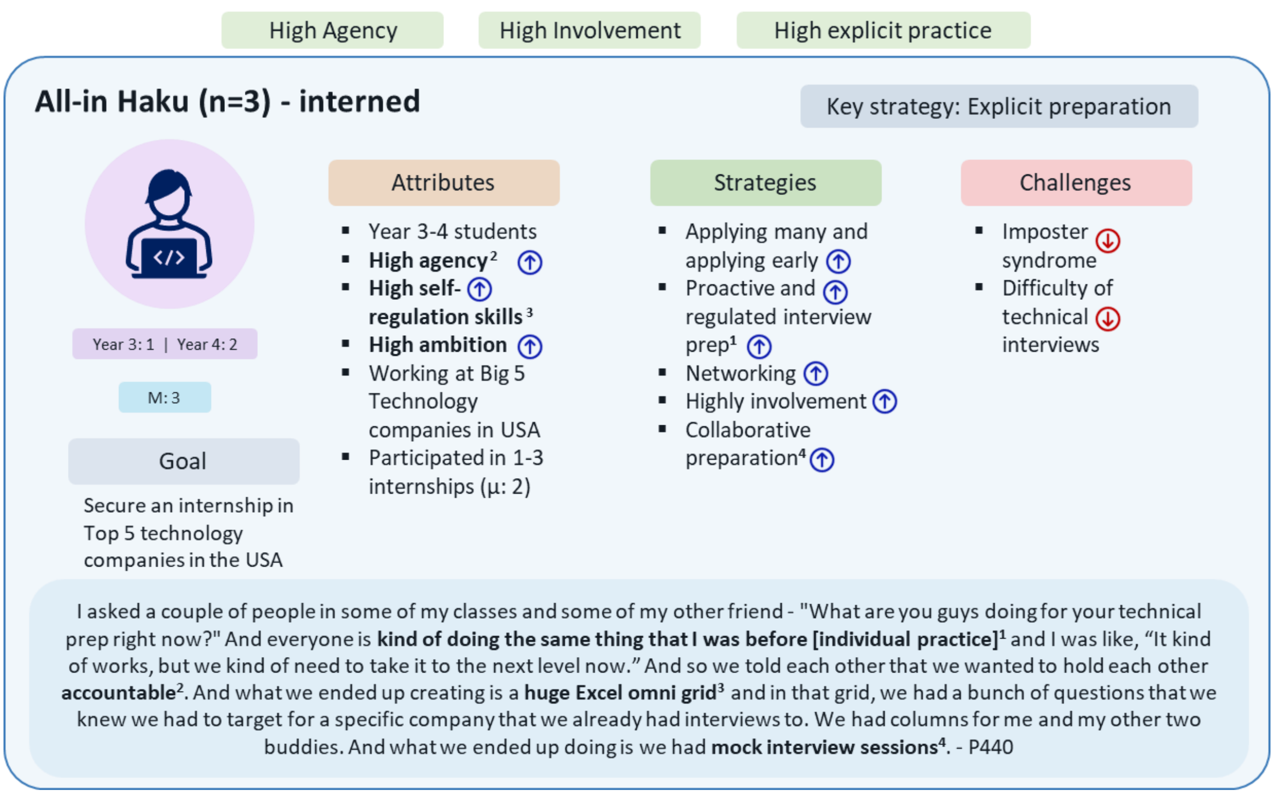


Figure 4-17. Persona describing All-in Haku (n=3), a student who interned

P440 was also a teaching assistant and proactively solved Leetcode problems independently which led him to secure a technical internship at a large bank where he interned first.

> I realized that companies, as soon as you have the interview, they ask content from the data structures and algorithms course. So in terms of the technical interview, I realized what I need to kind of focus on. So I started by myself, I haven't paired up with anybody. And I just started tackling random problems of the code. I didn't have any sort of methodology for it in the start, because I was like I don't know what I'm prepping for. But I know all of these types of things, I could potentially be asked something similar to this in a technical interview. And so in the start, that's what I kind of did. And it helped me to an extent, and I was able to get an internship and they asked me a technical question, and I was able to solve it really quick, and that's what eventually I think helped me get the internship.

However, he shared that independent practice was not enough for top technology companies, which led him to move into practicing mock interviews for "*two and a half months, everyday*" with two of his peers in order to secure an internship at a Big Five US Technology company,

> But then when I started looking at other companies that I was applying for as well, I realized that they were asking for a lot more in depth knowledge of the technical things that I was learning in data structures and algorithms. So that's when I realized that I needed to ramp up my skills entirely. And that's when I started trying to buddy up with people around me. So I asked a couple of people in some of my classes and some of my other friend. And I was like, "What are you guys doing for your technical prep right now?" And everyone is kind of doing the same thing that I was before and I was like, "It kind of works, but we kind of need to take it to the next level now."
>
> And so we wanted to hold each other accountable. And what we ended up creating is a huge Excel omni grid we called it. And in that omni grid, we had a bunch of questions that we knew we had to target for a specific company that we already had interviews to. We had columns for me and my other two buddies. And what we ended up doing is we had mock interview sessions. So at home, whenever any one of us was free, we'd solve our own questions whenever we wanted. But when we met up, we tried to look at questions that one person had not solved, and two people had solved already, and tried to ask the person the two people who had already solved the question are interviewing the person who hasn't solved

> the question already. And so that puts us into the interviewer situation, and it puts the other person into the interviewee situation, and it gets people thinking into that mindset.
>
> We rent out rooms in [library], or we'd meet at someone's home and we have whiteboards. And we'd actually try to represent a mock interview. And I think the skills that we kind of developed in that process are extremely valuable because we learned to do number one, keep each other accountable was the major thing. Because if I do not do a question the entire day, the other two will just be like, "What are you doing? You need to wrap up your skills."

After this extensive practice, not only did P440 succeed in getting an internship at a Big Five US technology company but also his two other peer group members landed offers in the same company.

> Both of them got [Big Five Technology company] as well. Since all three of us have prepped so hard, by the time we interviewed on site at [Big Five Technology company] in [anonymous state], we were all three of us were at the stage that we could tackle any difficulty level problem if it was thrown to us. And we kind of knew how to get hints in what the interviewers were looking for. Because we had that process of being interviewers, we knew what we were looking for when we were interviewing each other. So we knew what we were looking for. And we told the other person immediately right after they had their interview basically.

P440 also faced challenges when he initially was not able to secure internships, sharing that he faced imposter syndrome,

> So, it was kind of an imposter syndrome kind of deal where I was like, "Do I really belong in this industry if I'm not seeing the results coming out of all of the hard work that I'm putting into it." So getting over that was also a major barrier that I had to cross as well. So right now, I don't consider myself to have imposter syndrome anymore because I have seen the results in all the hard work that I have achieved so far.

However, he gained more confidence subsequent to preparing for and successfully navigating interviews by deprioritizing coursework,

> So we didn't give as much priority as we should have to class coursework, and we kind of prioritized, we know we can get this job already. So we kind of prioritized other things more than we did class work.

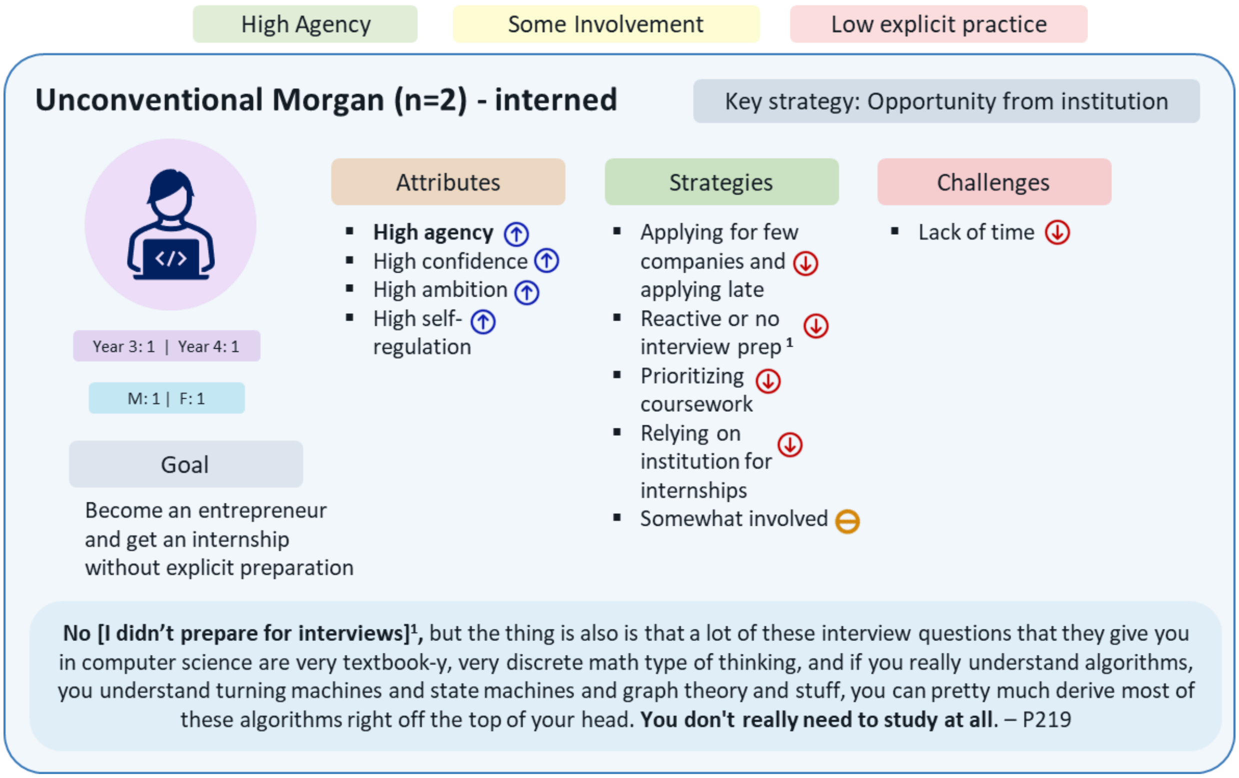


Figure 4-18. Persona describing Unconventional Morgan (n=2), a student who interned

4. Unconventional Morgan (n=2) - interned

Participants: P219, Y89

These students secured internships primarily through institutional support where the companies were either subsidiaries of the university or had a strong academic collaboration with the university for recruiting students locally. The two students who shared this persona were ambitious about their entrepreneurial aspirations but did not have a strong desire to pursue an internship. They were confident, demonstrated high agency in independent learning within their major, and sought knowledge across various fields they were interested in related to their entrepreneurial interests. They were somewhat involved in extracurricular computing activities outside their coursework. However, they did not prepare for interviews and applied to only a few companies often late into their programs. Additionally, they prioritized coursework and relied on it to secure an internship. One student who belonged to this persona was a male, the other a female, and both were in their junior or senior years.

An example of student who belonged to this persona was P219, male student in his senior year who was involved in part time work, clubs, hackathons, personal projects and research but decided that he did not want to prepare for interviews as the coursework would be sufficient to secure an internship,

> What I found is that most companies aren't going to hire you for building some brain simulation that controls a robot. Most companies, they're not going to hire you to build an AI day trader, anything like that. These advanced theoretical topics, I realize have almost no value in industry, and it's really nice to go into it whenever you're, just for the sake of understanding things, but in terms of simply just being able to solve a problem, most of these **recruiters** don't even really care about it. **The things that they would want me to do, what they're looking for are very ... to be honest, I would've called it rudimentary**. And, maybe that sounds arrogant, but that's my honest opinion.
>
> So, I feel like they would want me to sit there, and they want to make sure that I know what the difference between an abstract class and an interface is. And, I remember sitting there and multiple people asked me the same question. They said, "Do you know the difference between an abstract class and an interface?" And, I obviously know the difference. I explained it to them, and they're grilling me on the difference, as if I don't really know what I'm talking about, or maybe I just memorized the answer to that question or something.

P219 was a double major and wanted to become an entrepreneur. He exhibited high agency in developing technical skills by taking harder classes and had strong self-regulation skills to regulate learning independently. He secured an internship through his university at a large multinational company which had a local office through a series of panel based behavioral interviews. He emphasized that he did no preparation for any of the interviews except dressing professionally.

5. Tardy Taylor (n=1) - interned

Participants: P401

This persona represents a student who secured an internship based on her previous part-time experience in web and graphic design. She exhibited low agency and self-regulation skills, applying for internships very late in her program. She described that she was procrastinating and had low self-efficacy which was influenced by a low GPA, transfer challenges, and part-time work responsibilities. She was a female student in her fifth year and applied to internships very late,

> Aman: Didn't you **apply in junior or senior years for internships**?
>
> P401: **No, I didn't even apply. I didn't apply because of my GPA**, but at this point, I was like, "Okay. Well, it's better to do it even if you don't make it. Just try."

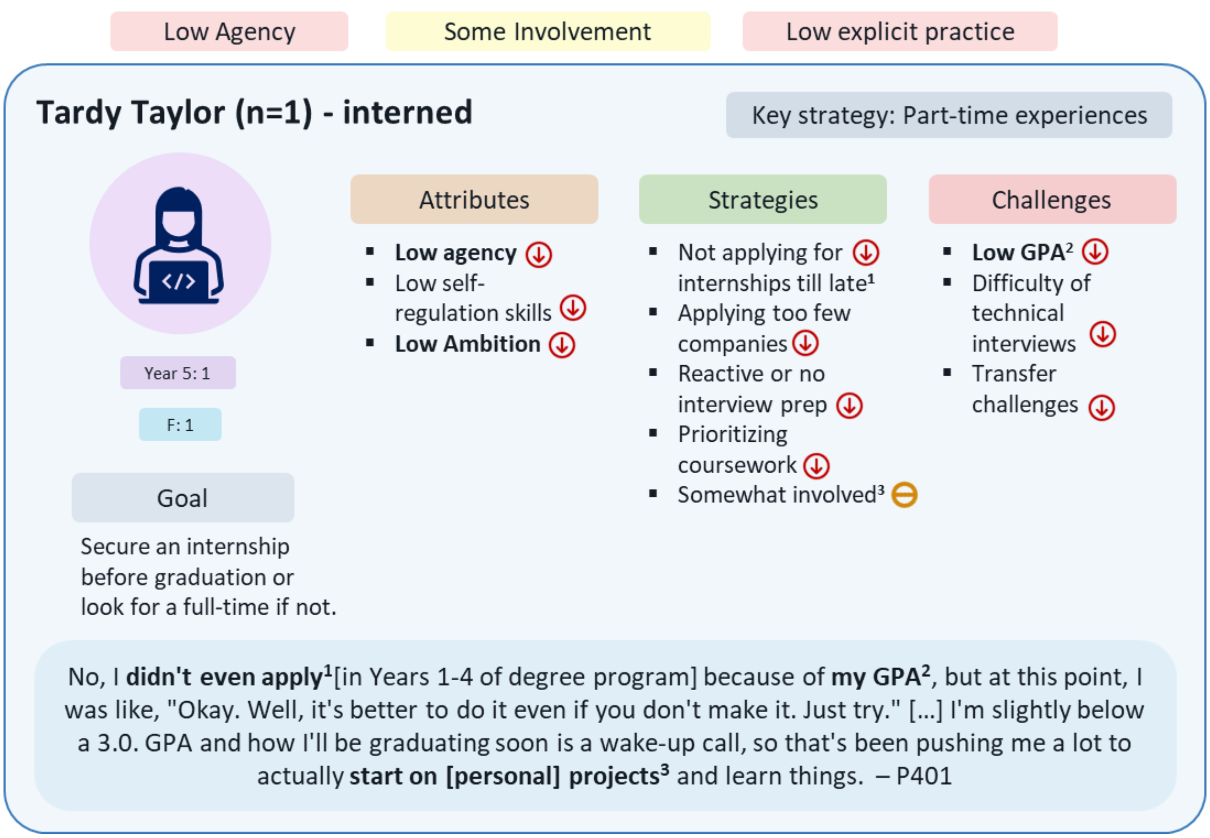


Figure 4-19. Persona describing Tardy Taylor (n=1), a student who interned

P401 prioritized coursework to improve her GPA and graduate, but she ultimately secured an internship right before graduation at a medium scale construction company through her university's career fair based on her part-time work experience in graphic design without a technical interview,

> I started applying for internships through the [university career center]. I've applied to about, I think, 10. Then this one that I'm currently interning for replied to me right away the next day. They called me at a set time, and they were talking about how they're looking for a front-end developer to design their new web application that they'll be releasing soon. He noticed that I've done a project for a class, and we made a website. He really liked the website with how we laid it out. I was in charge of the user interface and user experience of that, so he saw that and he wanted my help with their web application, so with that.
>
> **[The interview] was more of like a demo** and what I know. It wasn't really technical. I talked with the boss first, and he asked me what I know, and what I've used in past. Then after that, he passed me to his backend project manager. He talked about what they're looking for their front end. So since I know a lot about graphic design and how a website should look, that's what they were mostly interested in.

She exhibited low self-efficacy, and wasn't confident in her coding skills due to which she did not apply or started to apply very late into the program,

> I feel my **coding skills weren't that great** and the only thing I was really confident in was graphic design. So as a computer engineer, that's not something I should be confident in. I should be confident in coding or embedded systems.

Lastly, she had low involvement in extracurricular activities due to lack of time between coursework and her part time work,

> I would say my peers would be doing a lot better than I am for sure. I haven't been pushing myself hard enough for outside projects, solo projects.

4.4.4.8 Personas – students who were unable to participate in internship(s)

Students who did not intern (n=22) were categorized into five types of personas based on the challenges they faced when approaching the internship recruitment process. Additionally, their attributes and strategies were taken into account when segmenting these students.

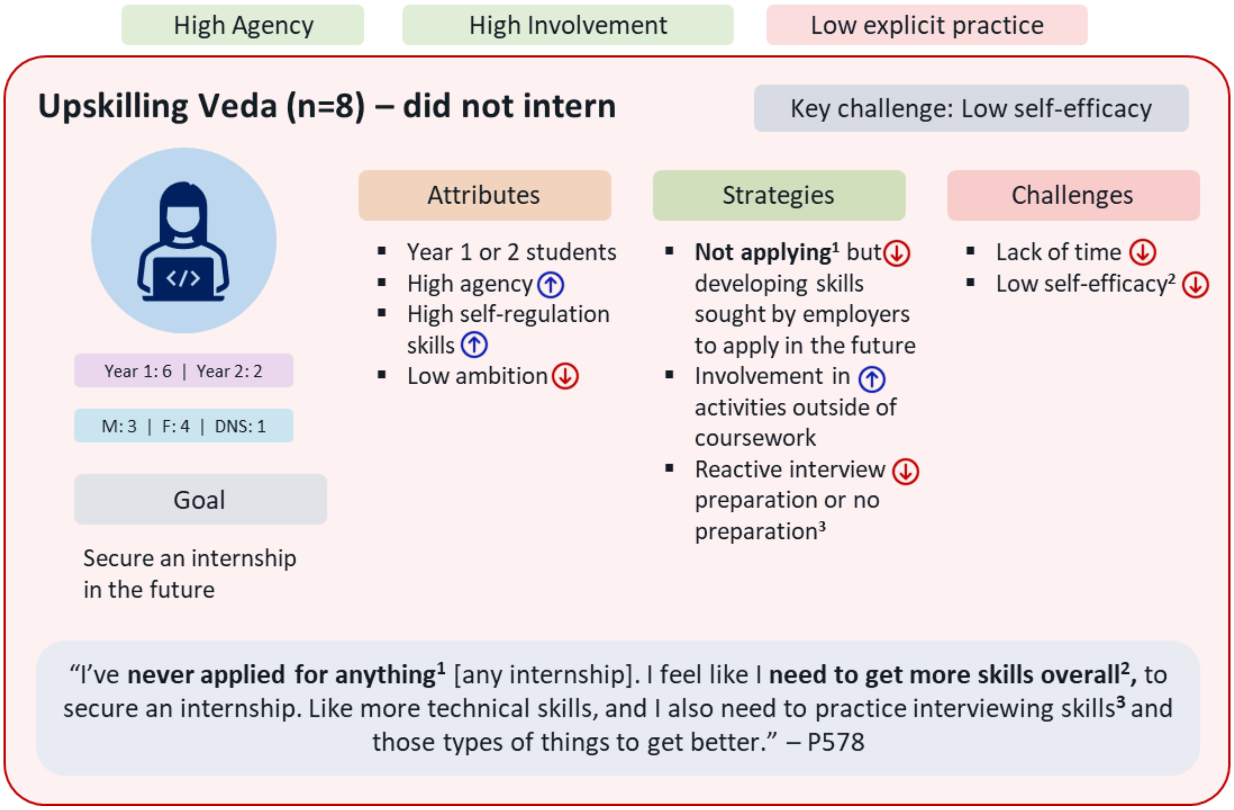


Figure 4-20. Persona describing Upskilling Veda (n=8), a student who did not intern

1. Upskilling Veda (n=8) – did not intern

Participants: Y82, Y84, Y91, Y90, P199, P223, P578, P692

These students were interested in applying for internships in the future and were actively building their skills through coursework and activities such as clubs, hackathons, and personal projects in order to secure an internship in the future (see Figure 4-20). All of these students were in their freshman or sophomore year and four students were females, three males, and one student did not specify their gender. These students had low confidence that they could secure an internship and often attributed a lack of experience to not applying for internships. Most of these students were not actively involved in looking for internship positions at the time of the interview, but they were building their credentials to apply for one in the future. A couple of students started applying for internships at the time of the interview.

An example of a student in this case is P578, a female in freshman year who was involved in research, leadership positions in clubs, and was actively building skills to pursue an internship in the future. She was not looking for internships at the time of the interview as she felt it was too early and she doesn't have skills to apply for one. She stated that she didn't secure an internship as she hasn't "*put [herself] out there to companies yet. [She has] kind of been focusing on adjusting to new life at UF and getting [her] feet in the ground with clubs and research, so [she hasn't] really applied to any company or looked for anything*". She stated that she "*feels like [she] needs to get more skills overall, [to secure an internship]. Like more technical skills, and [she] also needs to practice interviewing skills and those types of things to get better*". However, she wasn't actively preparing for interviews as she had a lack of time outside of her research, extra-curricular involvement, and extensive coursework. P578 never applied for internships in her freshman year but planned to apply for one in her sophomore year by applying at the career fair upcoming fall.

2. Delayed and Preoccupied Sage (n=7) – did not intern

Participants: P315, P341, P382, P412, P677, P710, P785

These students started applying for internships very late into the program and all of them were in junior through super-senior years (see Figure 4-21). Five of these students identified themselves as females and two as males. Two of these seven students switched majors in sophomore year, and four students transferred from a community college and faced challenges with coursework. These students were somewhat involved in activities outside of coursework but were not proactively preparing for technical interviews as they had alternative priorities to focus on part-time jobs and coursework. They often did not apply to internships or applied to a few positions due to lack of confidence. Additionally, they had low GPAs (n=4, low GPA here refers to 3.0 or below) or part-time work responsibilities (n=4) which led them to focus more on coursework over the process of securing an internship. Lastly, a few (n=2) were less aware of the internship recruitment process in their initial years in college and started working on the preparation process or getting involved in activities outside the coursework in the ultimate years of their programs.

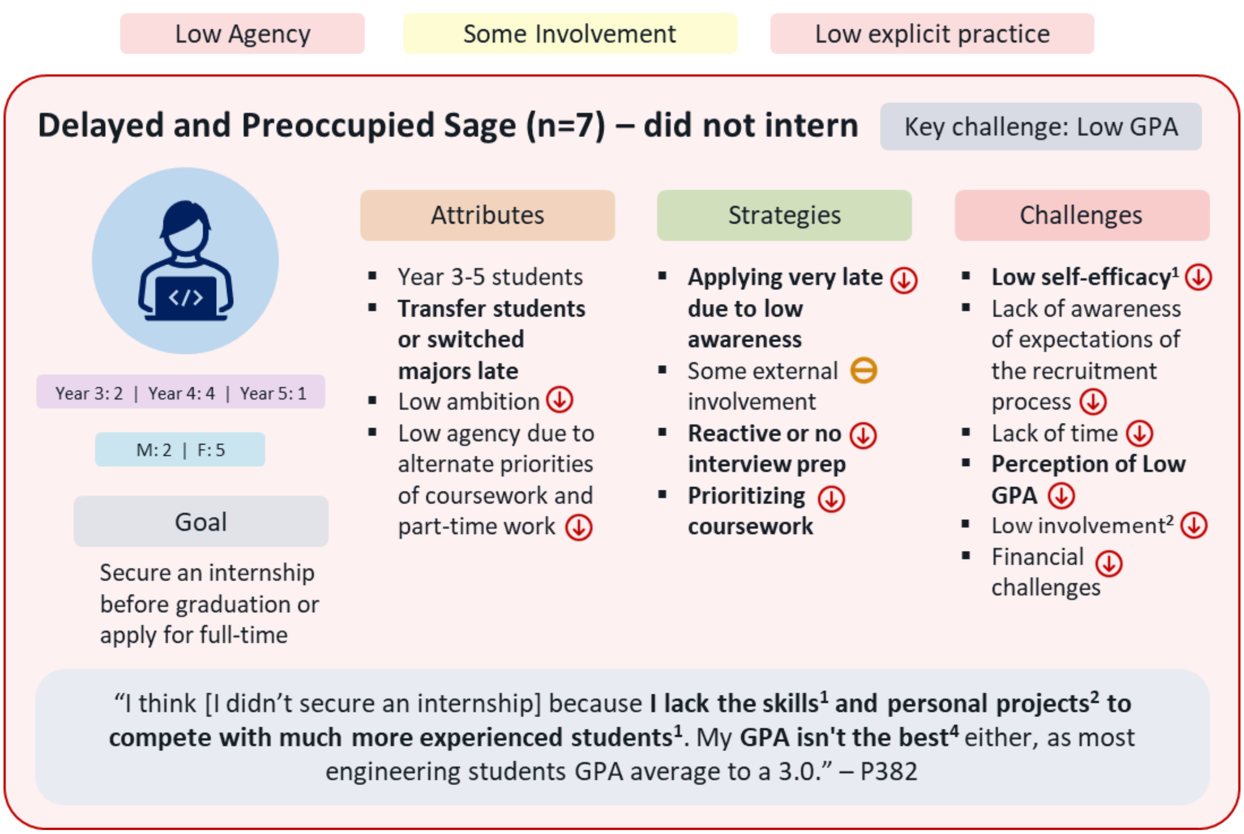


Figure 4-21. Persona describing Delayed Sage (n=7), a student who did not intern

An example of a student in this case is P382, a female in super-senior year in Computer Engineering (CE) major who was a transfer student in her current program and worked part-time as a graphics designer. She had a hard time transitioning as a transfer student and attributed her lack of confidence to the different cultures and harder courses at the university compared to a community college,

> I transferred from a university that weren't up to par as UF. And so seeing these people who started at UF as freshmen, and they know so much more than I do. So, that was kind of discouraging. […] I finally passed [Digital Logic] spring, that was my third time taking it. When I failed at a second time, I was like, Oh my God, I needed to get out of this career. Maybe I can get into like computer science. And they're like, Oh, you can't because you're a transfer student. So I'm like, I'll just finish it.

She pursued CE as she was interested in games. She was involved in clubs, personal projects, online courses, and certifications. She started getting involved in the latter three activities very late into the program after receiving feedback from the recruiters at the career fairs that they seek applicants with such experiences. She did not secure an internship as she was a transfer student, had a low GPA (below 3.0), and lacked the confidence to apply. She started applying for internships in her fifth year stating that she did not apply for internships in junior and senior year because she,

> thought that [she] had the misconception that once [she] gets a degree then [she'll] get a job. But [she] realized that in senior year or at my year now that [one] needs more experience than what the school has taught [them]. And nobody was there to tell [her] that like, what you learn at school isn't enough to get you a job unless [they] have a good GPA. But like, of course I don't have a good GPA.

Although, she was a part-time graphic designer interested in UX design, she applied only software engineering internships due to lack of confidence in her web skills,

> I didn't apply to those [UX related internships] yet, because I feel like my HTML and CSS knowledge isn't up to par with their expectations. So that's why I wanted to take the certification as soon as possible.

After applying to many companies for internships, she received an interview call from a medium sized local technology company, but she failed to clear their coding interview. She was “*denied to every paid internship*” and had “*begun to apply to unpaid internships*” for the next summer. She also attributed that her lack of participation in personal projects hindered her ability to secure an internship,

> I don't have any personal projects done, but I am working on it. And at my year now, I should probably have like two, or three personal projects done. I mean I have all my resume, like I put down things that I've done for class, but I kind of like said that add personal projects so that I have some sort of leverage in getting an internship.

3. Hesitant Cameron (n=3) – did not intern

Participants: P674, P591, P690

These students were somewhat interested in applying for internships but were not fully committed to the process due to a fallback – Plan B such as working full-time at the part-time employer, as an instructor in an unrelated sports field due to self-interest or working as a teaching assistant over the summer (see Figure 4-22). They would apply for internships very late into the program and to a few positions. Also, they were unaware of options for internships in specific subdisciplines such as computer networks, data science or cybersecurity and were hesitant to reach out to others given a lack of a strong network. These students exhibited low agency or proactiveness for involvement and explicit interview preparation as well as had low confidence in their technical skills. In addition, they were complacent, would often procrastinate, and showed low resilience when they stopped applying for internships after setbacks in a few internship applications. All of these students were males in years 2-5 in their programs.

An example of a student in this case is P591, a male in sophomore year who was having a hard time finding internships in cybersecurity, an area he was interested in,

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

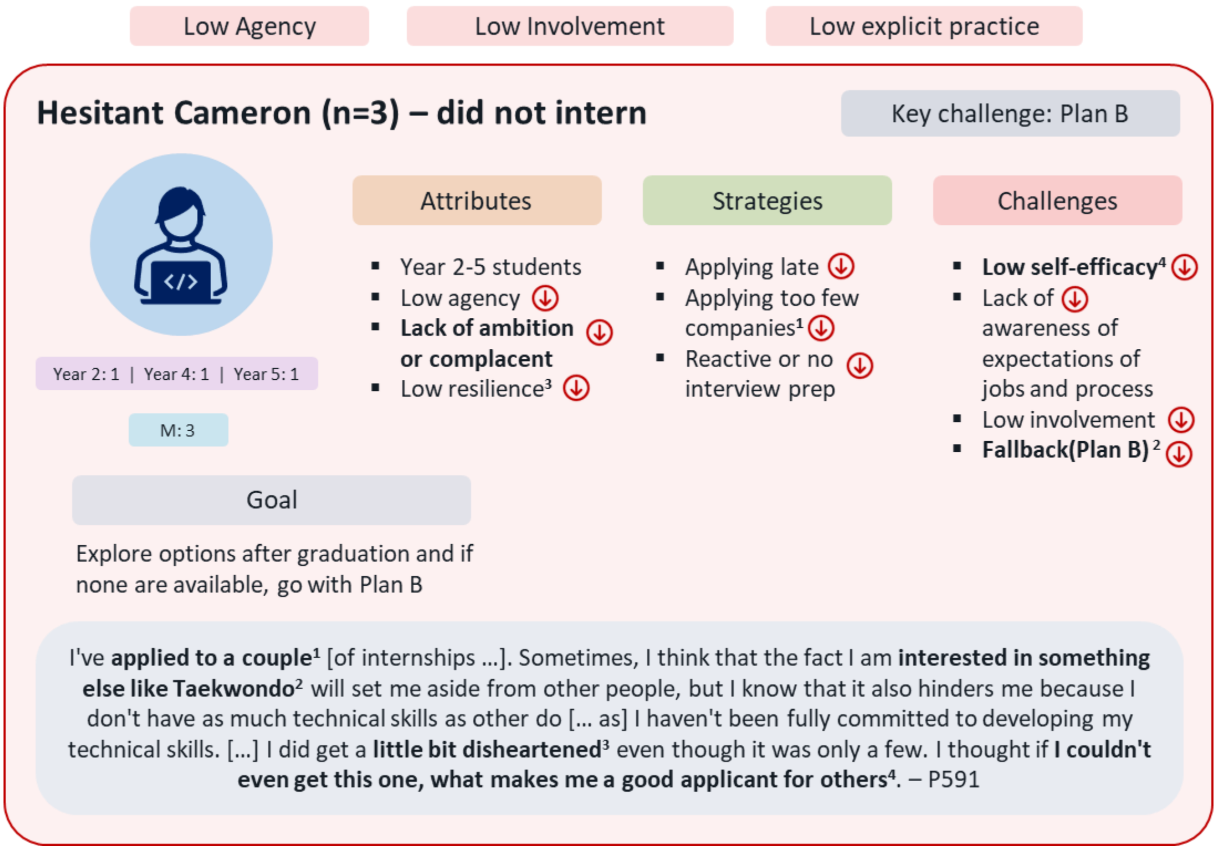


Figure 4-22. Persona describing Hesitant Cameron (n=3), a student who did not intern

He was also working as a part-time Taekwondo Instructor at the time of the interview and wanted to open a Taekwondo school after graduation and work in cybersecurity,

> I believe that I can do both. I **can become that Taekwondo instructor maybe part-time, and do this full-time**. I don't know. Maybe I could do half and half. I like doing Taekwondo, it's great, but compute science challenges me mentally to do things, to learn more. I like that and I want a profession, possibly, that pushes me to do that every day.

P591 was participating in cybersecurity club and pursuing courses in cybersecurity but was not proactively preparing for interviews, taking a reactive approach after landing interviews. He had a fallback (Plan B) of pursuing Taekwondo, which made him less committed to preparing for computing job preparation process,

> My success isn't probably where I want it to be right now. I know that being at [the university], you just have to put in a lot of effort. That means going to hackathons, that means making projects a lot. For me, it's just been harder to do that because of this idea **that I want to do cyber security, but I also want to do Taekwondo**. I **haven't been fully committed**, but I know that to be successful, you need to be fully committed.

He further stated that he applied to too few companies and lacked confidence,

> I've applied to a couple [of internships]. I just think it's very competitive or maybe the ones I've been applying to have just been very competitive. Sometimes, I think that the fact I am interested in something else like **Taekwondo** will set me aside from other people, but I know that it also **hinders me because I don't have as much technical skills as other do**. I **know they've put the time into that, so that's why I feel I haven't been able to secure one. Because I haven't been fully committed to developing my technical skills**.

P591 also exhibited less resilience as he didn't apply to many internships after facing setbacks in early applications, self-doubting his competencies to secure one,

> I did get a little bit disheartened, even though it was only a few [companies I applied to]. I thought if I couldn't even get this one, what makes me a good applicant for others.

4. Obligated Jollie (n=2) – did not intern

Participants: P600, P410

These students were interested in applying for internships but had constraints for joining a certain company after getting an offer due to financial and legal reasons (see Figure 4-23). One of the students had a hard time pursuing an internship due to family and financial reasons and she secured and declined an internship due to a low salary. She would prefer a high paying internship to be able to actually participate in one. Another student said that they could not participate in internships in certain companies because they manage many open-source projects and if they were to participate, then the employer could exert rights over those projects given that the project development could not be stalled over the internship period. These students were highly ambitious, had agency, were confident, had high GPAs and were involved in many extracurricular activities. However, they were not proactively preparing for interviews. One of these students was a male and another a female. These students were in years 3-4 in their degree programs.

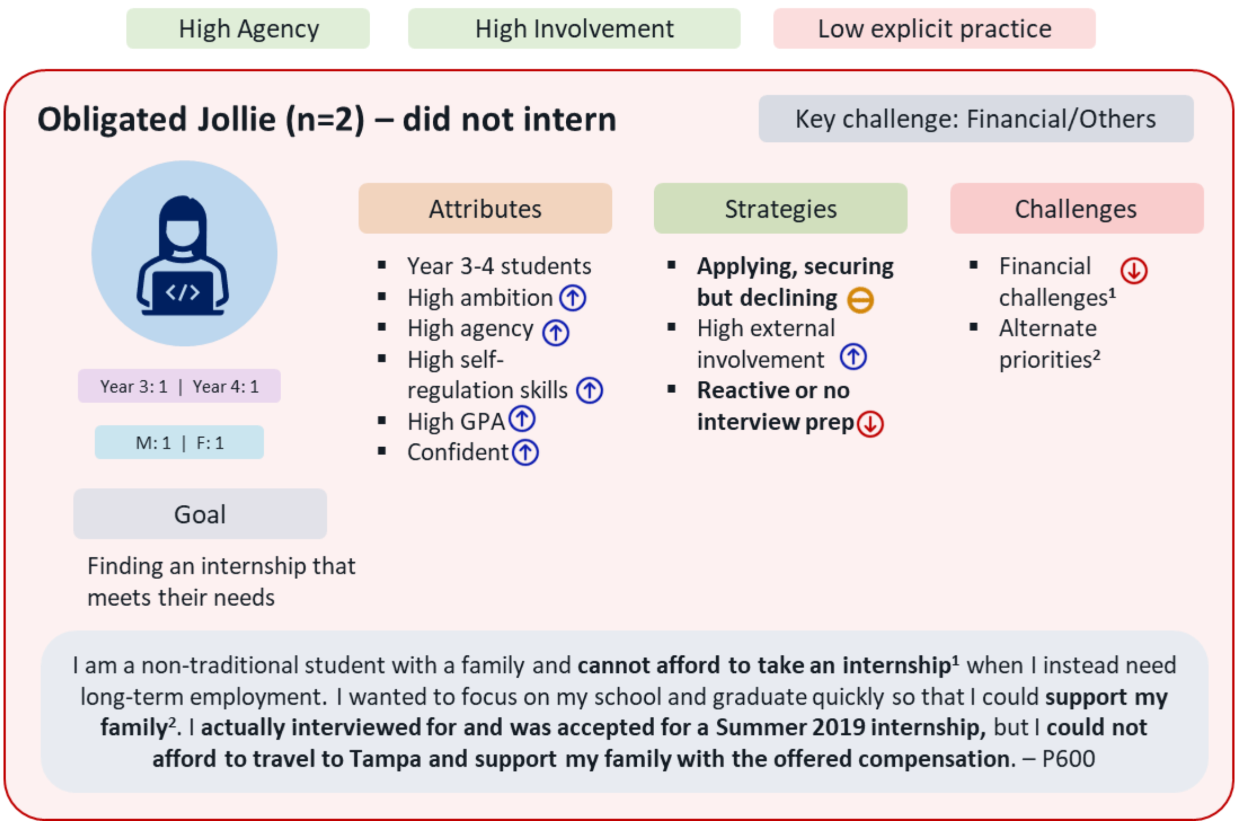


Figure 4-23. Persona describing Obligated Jollie (n=2), a student who did not intern

An example of a student who belonged to this persona is P600, a female in senior year in the online program who was also a stay-at-home parent who secured an internship but couldn't pursue it due to financial and family obligations.

> 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. […] Their **offer letter was just not at all in the same ballpark as like American Express or Microsoft or Facebook** or any of those guys. **So I declined** to them because it would have been a financially poor decision for me to go over there.

She was proactively building technical skills and was planning to work in the area of cybersecurity. To build skills in this area she shared that she proactively reads blogs and builds technical competencies in this area outside of coursework,

> So, number one, you have to **stay up to date**. So there's a lot of **different security blogs that I follow**. One in particular that I really enjoy and always refer to other people, it's called Krebs on Security. It's written by Brian Krebs who is an independent cybersecurity researcher, I don't know if you're familiar with him. He always has his hand on the pulse as far as new breaches and whatnot that are going through, particularly about the credit card theft. Other things too is that I have my **professional Twitter account where I follow a bunch of different blogs**. There's like, Dark Reading is one of them, I can pretty much pull it up now. There's like the TrustedSec Blog, and TrustedSec actually is one of the local big name security companies here in the greater Cleveland area because I moved to Cleveland in June. There's Dark Reading, there's Occupy the Web, Malware Tech.
>
> I'll also follow the big names just like AWS Support because there is a huge DDoS of AWS a couple of weeks ago or like a month ago now. And then like US Cert of course, just to see what the government is wanting to publish. Schneier Blog as well. So just like those kinds of names. And what I'll do also to practice my skills […]. But what I've been doing is that there are some **videos [on YouTube] I've watched of how to use Kali Linux** to break into your own network essentially, **how to use a bunch of the tools** that come in a Kali Linux distribution.

She did secure a full-time job in cybersecurity due to her technical skills and proactiveness, but she also described her challenges of a lack of time to prepare for stressful technical interviews,

> I'm in a very unique situation where I **don't have all of the free time to dedicate to code and interviewing practice** and all that kind of stuff. I

stayed at home **watching** him **[her kid].** I didn't get to put him in daycare and then have all the free time. I was just trying to complete stuff while also watching him. Yeah, it's very different when you **don't have as much free time to dedicate to the side projects or personal projects, the interview prep, the LeetCode, all that stuff**.

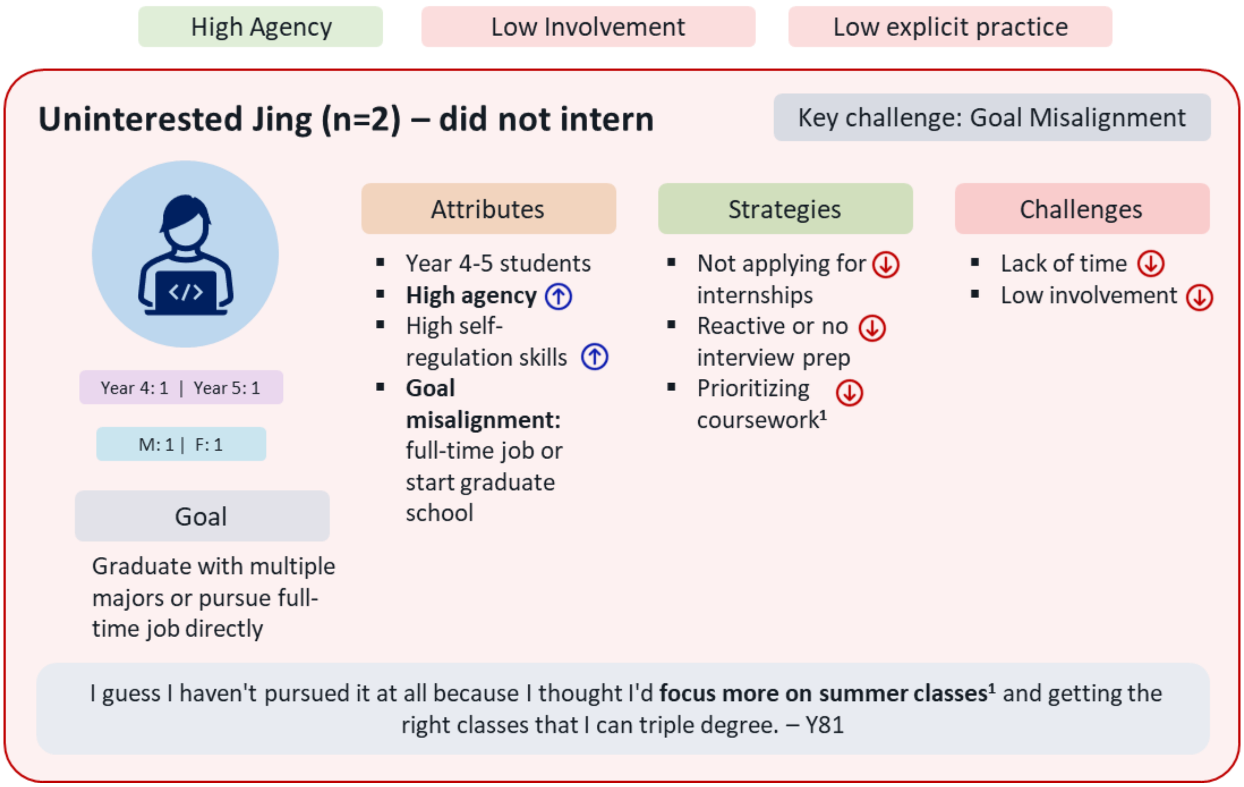


Figure 4-24. Persona describing Uninterested Jing (n=2), a student who did not intern

5. Uninterested Jing (n=2) – did not intern

Participants: P526, Y81

These students were not interested in applying for internships due to focus on coursework because they were pursuing multiple degrees, or they already had a full-time job where they worked and pursued the degree program part-time (see Figure 4-24). They had high agency and showed strong self-regulation skills juggling coursework and work, but they did not have time outside of their responsibilities to participate in extra-curricular activities or prepare for interviews. They were not applying for internships due to a lack of interest in pursuing one. One of these students was a male and another a female. These students were in years 4-5 in their degree programs.

For example, a male student in super-senior year, Y81 who did not participate in internships embodied this persona. He confirmed that he was neither preparing nor applying for internships,

> I think about straight diving into grad school and trying to get a job. […] **I haven't pursued [internship] at all because I thought I'd focus more on summer classes** and getting the right classes that I can triple degree.

He described that he was not involved in activities outside the coursework due to lack of time and was confident that the coursework would be enough for him to land a full-time job after graduation.

4.4.4.9 Key findings from personas

We categorized students who participated in internships and those who did not based on salient attributes, strategies, and challenges. Our analysis identified five personas representing students who successfully secured internships and five personas representing those who did not.

Among the majority of students who obtained internships, a common theme was agency. These students frequently applied to multiple companies early, proactively engaged in opportunities outside what was required in the curriculum and explicitly prepared for interviews - consistent with findings from our larger survey analysis. Additionally, they demonstrated resilience, persisting in their efforts even after failing to secure an internship in their early years.

For example, students like “Driven Billie” demonstrated proactiveness and resilience to secure computing internships at companies ranging from small startups to well-established firms. Meanwhile, students like “All-in Haku” took this high exhibition of agency a step further, combining it with strong self-regulation skills to prepare rigorously for technical interviews, ultimately securing internships at more prestigious and selective Big Five technology companies in the U.S. Other students, such as “Resourceful Alex”, primarily leveraged conferences and networking to secure internships where the technical interview process was comparatively less rigorous and the bar for securing an internship was quite low.

Among students who did not intern, those exhibiting traits similar to “Upskilling Veda” were proactive in building skills but refrained from applying due to a lack of confidence in their freshman and sophomore years. These students were on a trajectory to participate in internships in the future, eventually transitioning into the “Driven Billie” persona. However, students like “Delayed and Preoccupied Sage” and “Obligated Jollie” faced barriers such as limited time, lack of external involvement, or a low GPA, which led them to prioritize coursework. Many of these students had transferred from community college, switched majors, or were engaged in part-time work or family responsibilities, leaving them with little time for interview preparation and diminishing their confidence in securing internships. Additionally, students like “Hesitant Cameron”, and “Uninterested Jing” did not apply to internships due to low confidence and the presence of a fallback - Plan B. Interventions should be introduced to support these types of students in securing internship opportunities in order for them to be successful in their professional careers.

4.5 Discussion and Conclusion

4.5.1 Internship Participation and Students’ Preparation Process (RQ1 and RQ2)

We found that 40% of computing 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 [117]. 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 [105], 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 [22, 138, 139].

Within the context of Bandura's properties for human agency [8], we observed that interns were more likely to be intentional in their approaches regarding the 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 or peer. 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?

4.5.2 Barriers to Internship Participation (RQ3)

Our work also contributes to the Computing Education literature understanding of the barriers that hinder computing undergraduate students' ability to secure industry internships. Four themes emerged related to these barriers: low self-efficacy, actions to secure internships, alternate priority, and application process challenges. We found that a majority of students who did 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 pursued an internship [84]. 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. 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 [84], thus contradicting these students' conceptions.

Further, computing 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 [93]. 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 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 [93]. 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 computing 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 [8], 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 the agentic resources necessary to thrive through the recruitment process.

4.5.3 Factors Influencing Students' Participation in Internships (RQ4)

The regression results in Paper 3 show that year in school, household income, external involvement score, and diffusion identity status score are significant predictors of internship participation in our model. Therefore, we reject the null hypothesis that there are no factors in our model that have a significant relationship with computing students' participation in internships. These results corroborate the findings in our bivariate analysis that factors outside the curriculum are at play that influences students' participation in internships. Our results also align with Hoekstra's study [69] which found age (correlated with the year in school) and participation in high-impact practices were significant predictors of securing internships in all majors. However, unlike Hoekstra's study, we did not find a relationship between race and gender and participation in internships in computing. This reduced disparity in computing could be because of strong labor markets and job opportunities in computing. Lastly, diffusion identity status seems to have a significant impact on internship participation. While higher exploration or higher commitment might not predict participation in an internship, a student in a lower commitment and lower exploration mode might face challenges in securing an internship. In the future, we would like to explore who are the students that are "stuck" in diffusion status. Are they freshmen or senior students? Finally, we would like to explore creating predictive machine-learning models for predicting students' participation in internships.

4.5.4 Differences Between Students Who Participate in Internships and Those Who Do Not (Interview Data Analysis, RQ5)

The findings from our analysis highlight key differences in attributes, strategies, and challenges between students who successfully secured internships and those who did not. These insights provide valuable implications for both students seeking internships and institutions aiming to support students in their career development.

Proactiveness, agency & explicit preparation as key differentiators. A significant takeaway from our study is that students who obtained internships consistently exhibited high levels of proactiveness, agency, resilience, and self-regulation when preparing for the recruitment process. These students took early and strategic steps toward securing internships, such as applying in their freshman and sophomore years, engaging in networking activities, refining their resumes, and preparing for behavioral and technical interviews well in advance. The personas of "Driven Billie", "All-in Haku", and "Resourceful Alex" exemplify students who took proactive measures and demonstrated persistence, ultimately securing positions at a range of companies.

Conversely, students who did not participate in internships often lacked these proactive behaviors. Many either postponed applications, applied to fewer companies, or prioritized coursework over internship preparation. Personas such as "Upskilling Veda" were on a trajectory toward securing internships but initially lacked the confidence or awareness to apply. Others, like "Delayed and Preoccupied Sage" and "Obligated Jollie", faced additional barriers such as low GPA, time constraints, and external responsibilities, which hindered their ability to engage fully in the internship process.

Strategic approaches to securing internships. Students who secured internships employed diverse strategies beyond simply submitting applications. Many leveraged professional connections, attended industry conferences, engaged in mentorship programs, and sought referrals. Their approach to interview preparation was also notably different - they prepared before applying rather than waiting until an interview invitation was received. In contrast, students who did not intern often took a reactive approach, only preparing when required or not preparing at all.

Despite these differences, both groups of students were actively engaged in skill-building and sought guidance from mentors and peers. This suggests that while skill development is necessary, it is not sufficient on its own. Targeted strategies and proactive engagement play crucial roles in securing internships.

Barriers and challenges in internship attainment. Both groups of students, those who participated in internships and those who did not, faced psychological, socio-economic, process, and structural challenges. Even students who successfully obtained internships reported struggling with imposter syndrome, interview-related stress, and lack of confidence. However, students who did not intern faced additional challenges, such as financial constraints, family obligations, low GPA, and limited external involvement. Some students also encountered structural barriers like visa restrictions, coursework issues after transferring from community colleges, or switching majors, which affected their approach to seeking internships. Some students who did not intern also had a fallback plan (Plan B), such as “Hesitant Cameron” and “Uninterested Jing”.

These students often deprioritized internships, either due to an alternative career path or a belief that they could rely on other opportunities, further reinforcing a lack of agency.

Concluding thoughts. A noticeable observation from the personas we developed was that I did not find a single student who did not participate in an internship but was actively trying to secure one and was both involved outside the curriculum and proactively preparing for interviews. **This suggests that if a student sets a goal to pursue an internship and takes proactive steps toward getting involvement in activities outside the coursework and explicit interview preparation, there was no apparent reason for them to fail in securing one.** However, this data is from the pre Covid-19 period and is also influenced by fluctuations in internship hiring within the technology labor market. As a result, the proportion of students that embody a persona which was observed in our findings may not hold under varying labor market conditions. Nevertheless, since these personas are derived from student behavior, we believe that the underlying patterns should remain relevant, even as labor market conditions shift.

4.6 Recommendations

Based on our findings, we propose the following recommendations to better support students in securing internships,

4.6.1 Recommendations for departments

1. **Increase awareness of the importance of internships, recruitment process, and available opportunities.** Many students in our sample were unaware of internship programs designed for early-year students and opportunities beyond mainstream software development. They often struggled to understand available career paths in CS subfields such as computer networking, AI, machine learning, user experience, and

data science. Career advisors and faculty should provide targeted guidance on these diverse computing disciplines, including cybersecurity, data science, and industry-specific internship pathways. At one of the sites where we collected data, Rose-Hulman Institute of Technology, students described how their institution raised awareness about internships through a mandatory freshman program offered by Student Career Services. These sessions introduced students to the importance of internships, resume building, interview expectations, and insights from alumni on career options. Students found such programs particularly helpful in navigating their career paths.

2. **Encouraging students to apply early and to many companies**. Institutions should emphasize the importance of early application and applying to many companies when seeking internships. Many students miss opportunities because they apply late or to too few companies. Encouraging students to start applying in their freshman and sophomore years can significantly increase their chances of success.

3. **Emphasize students getting involved in activities outside the curriculum and funding such activities**. Many successful internship candidates were engaged outside of the curriculum in activities such as hackathons, student clubs or coding competitions. Institutions should clearly communicate the need for students to get involved in these activities.

4. **Recommend students prepare for interviews and offer courses or interventions in courses to help students be ready for interviews**. To improve students' internship success rates, institutions should advocate students to prepare for technical and behavioral interviews well in advance. Additionally, they can offer dedicated courses or workshops focused on interview readiness. Students who did not intern in our sample

could not prepare for the internship recruitment process due to alternate priorities. Thus, such programs can cover topics such as common interview patterns, whiteboarding exercises, mock technical interviews, and behavioral question strategies which build students confidence to succeed in interviews. Incorporating real-world coding assessments and mock interviews into the curriculum can further bridge the gap between academic learning and industry expectations. Additionally, universities can collaborate with alumni and industry professionals to conduct mock interview sessions and mentorship programs, providing students with insights into current hiring trends and expectations. 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 [93]. 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.

5. **Promote conferences and provide financial support for attendance.** Conferences and industry events provide students with valuable networking opportunities. However, financial constraints can limit participation. Institutions should actively promote these events and offer scholarships or travel grants to students who cannot afford to attend, ensuring equitable access to career opportunities.

4.6.2 Recommendations for instructors

1. **Adjust coursework during peak recruiting periods.** Career fairs and recruiting seasons often coincide with demanding coursework, making it difficult for students to balance both. Institutions should consider offering flexibility in deadlines or reduced coursework loads during these critical times, ensuring students can fully engage in the

recruiting process without academic penalties. Additionally, instructors can support students by relaxing attendance policies during career fair periods and avoiding major assessment deadlines on career fair days. This flexibility allows students to fully engage in networking and recruitment opportunities without the added pressure of missing classes or deadlines.

2. Incorporating skill development and authentic tools in course workflows: 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 [184] for submitting projects so that students can show their portfolio to recruiters or using online code judges in Data Structures and Algorithms courses where students can practice the implementation of various data structures for technical interviews. This is necessary as computing students who have responsibilities outside of the classroom, such as work have limited opportunities for participation in extracurricular activities at the university.

By implementing these recommendations, institutions and instructors can bridge the gap between students who secure internships and those who struggle to do so, ultimately enhancing career readiness and improving student outcomes.

4.7 Limitations

Sample representation: Our findings represent a snapshot of the internship experiences taken from a sample of CS students at three US-based universities where participation in internships was optional. The results may or may not generalize to other majors, institutions, or geographic areas, especially to programs where the employment recruitment process or employment opportunities for internships are dissimilar to the

US. Nevertheless, our goal was to explore the complex internship participation process in depth. We provide a description of the research sites and suggest boundaries, scope, and context on where our findings will generalize to the broader populations so that the readers can make appropriate inferences of our findings at similar institutions.

Moreover, our samples 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. For instance, the number of students at Site B (57%) who interned were higher than those at Site A (40%). A 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. We also had a lower representation of certain groups such as Females and African Americans, but such groups were proportional to the respective proportions at the individual universities.

Interpretation bias and validity in surveys: Data collected from survey-based research can induce response bias or interpretation of questions different from a researcher's intended meaning of a prompt. To mitigate this, we used insights from the analysis of our pilot study to reduce the interpretation bias of survey questions.

Additionally, we use data from interviews as well to strengthen the validity of our results from multiple data sources. Survey data from our study is observational, and results should not be interpreted as causal relationships.

Reliability and validity of qualitative analysis: The coding process for open-ended responses of our survey and interview data can be influenced by our biases and could have subjective interpretation. We attempt to validate our inductive content analysis through the transparency of our research process, using representative quotes from participants, and recognizing our positionality to improve reliability and validity of our analysis.

Additionally, while personas as an analytical tool can help communicate the difference between computing students who participate in internships and those who do not to a variety of stakeholders, they do have certain limitations.

First, personas are based on generalized characteristics and behaviors which may not represent diverse students. We resolved the inclusion of voices through (1) purposefully recruited students in our interview sample to understand eclectic viewpoints and (2) by developing multiple personas beyond the dichotomy of successful vs unsuccessful student personas that characterize students based on attributes and behaviors.

Second, there is a risk of creating personas that reinforce stereotypes [132]. I am transparent about my data analysis process, and back the personas using authentic quotes and empirical frequency analysis of our qualitative codes so that the stakeholders can understand the limit and importance of our personas.

Third, personas and qualitative research findings can be limited to specific populations and opponents have argued that personas do not "*determine how many, if any, users are represented by a persona*" [30]. My goal is to use our personas for empathetically communicating the types and challenges of students to the stakeholders in academic programs so they can use these results to introduce interventions or build inclusive academic programs supporting the needs of eclectic students.

Limitations of our quantitative analysis: Imputing missing data before running a model has a chance to increase the underestimation of standard errors and overestimation of test statistics [1]. Given that the overall missing data in our survey was relatively low (1.4%) when compared with the number of responses that had missing data (40%), we decided to impute data rather than discard responses. We report our data imputation technique for better transparency.

Our EOM-EIS identity scales in the survey had lower internal consistency due to the limited number of items used for each status. However, the Cronbach Alpha values were comparable to prior work. Additionally, we chose a logistic regression model for its simplicity, effectiveness, and lack of baselines. Prior work has observed that logistic regression produces somewhat comparable results as more advanced models in social sciences research [144]. However, our findings could be biased by the choice of our modeling technique and results from using other advanced models might yield different results.

Lastly, the model presented in this chapter (Table 4-14) treats ordinally encoded variables like year in school and household income as continuous for simplicity. However, this method assumes linear effects between the intervals. These categorical variables may be better represented using one-hot encoding/dummy variables and dropping a column representative of a baseline. For example, we may assume that students are more likely to intern during the summer after their junior year compared to the summer after their freshman year (as students would have taken more advanced courses which are required for certain internships). If this is the case, the intervals are non-linear, and the continuous assumption of our model is naïve. In future iterations of this work, it may be of value to modify the ordinal representations using dummy variables for each of the categories and a baseline for year in school.

4.8 Lessons Learned for Subsequent Studies

We found that a majority of computing students in our sample (60%) did not participate in internships. These students were less engaged in preparing to secure internships due to lack of agency or awareness of the recruitment process, had lower self-efficacy, and were impacted by alternate priorities such as financial, familial, or work responsibilities. Additionally, there is no known cohesive framework that provides researchers tools to investigate student participation in internships and answer the following question: What distinguishes a computing undergraduate student who has participated in several internships before graduation from those who have not participated in any internships? We also observed that the industry recruitment process for internships expects student involvement outside the already overloaded computing curriculum. Hence, we need to develop support programs to prepare our students for securing internships within the curriculum so that our students become more aware as well as gain the necessary skills they need for securing internships using a more equitable approach. In order to solve this problem and improve students' awareness of the job recruitment process as well as prepare them for this process, we designed, implemented, and evaluated an intervention called "*Hire Thy Gator Technical Interview Exercises*", which we will describe in the next Chapter.

CHAPTER 5
STUDY 3: HOW CAN WE IMPROVE OUR CURRICULUM SO THAT MORE STUDENTS INTERN?

Given the importance of internships in computing (Chapter 3), it is concerning that only 40% students participate in internships across the undergraduate computing program (Chapter 4). Hence, we created a pedagogical intervention to prepare students for applying and securing internships by building their confidence. In this section, we elaborate on logistics and evaluation of our intervention called *Hire Thy Gator Technical Interview Exercises.* This study was conducted in summer and fall 2020, and the intervention was introduced in fall 2020. Data from this study was published in the following conference proceedings between 2021-2023:

1. *Introducing a Technical Interview Preparation Activity in a Data Structures and Algorithms Course* at the ACM ITiCSE 2021 Conference in the Tips, Techniques, and Coursework Track (Short paper) [81].
2. *Implementation and Evaluation of Technical Interview Preparation Activities in a Data Structures and Algorithms Course* at the ACM SIGCSE TS 2023 Conference in the Experience Reports Track (Full paper) [84].

I was the lead author on both papers and Dr. Gardner-McCune was the supervisor and co-author. For the second paper, an undergraduate student researcher, Sajani Panchal was the second author, and she helped on qualitative analysis as well as conducting a literature review in the area. In this section, we will use data and results from the above papers as well as analysis from an additional research question which we haven’t published so far. The latter question (RQ1b, Section 5.7.2) investigates the perception of efficacy of our intervention for different roles (students’ participation as an interviewer vs interviewee).

5.1 Overview

One role of computing degree programs is to educate individuals so they can contribute to the economy by joining the workforce. This goal aligns with the majority of computing students' aspirations to secure jobs in the industry after graduation [78]. Unfortunately, most undergraduates in a computing major have to devote career preparation time for technical interviews outside of coursework as these interviews act as gatekeepers to internships and full-time jobs in the technology industry [11, 76, 106, 152]. This need for time outside of the curriculum is unfavorable and inequitable, especially for students of low socioeconomic backgrounds who may not have substantial time outside of the curriculum due to family or work responsibilities [76]. In addition, students find these technical interviews as anxiety inducing and stressful [12]. To solve these issues, we introduced *Hire Thy Gator technical interview preparation activities* to familiarize students with the interview process and build students' confidence to succeed in these interviews.

In this section, we describe and evaluate the introduction of Hire Thy Gator technical interview preparation activities in a Data Structures and Algorithms (DSA) course. Our intervention included a panel on internship experiences, a role-play interview demonstration, two participatory mock interview preparation exercises where students interviewed each other first using self-selected peers and second through random pair-ups and graded short programming problems. The content of the technical interviews has a broad overlap with DSA courses [106] and hence our activities were introduced in this course. We will (1) explain the logistics and rationale for embedding these activities, (2) describe the lessons learned and evolution of the activities beyond the intervention semester, and (3) evaluate the impact of these activities on students.

We report data from 257 students who participated in our intervention and 106 students who were a part of a control group. Students found that taking roles as an interviewer and interviewee increased their familiarity with the recruitment process, allowed them to self-evaluate their strengths and weaknesses, and prepared them for technical interviews. Quantitatively, the intervention cohort that participated in our activities reported a higher average normalized confidence gain (0.42) than the control group (0.36) indicating that our activities can aid in building students' confidence. Our work contributes rich descriptions and preliminary evaluation of a scalable, collaborative, and formative professional development activity which can support students' awareness and preparation for future technical interviews as well as scaffold students' transition between coursework and technical interview preparation equitably.

5.2 Related Work

The hiring process in the US varies for roles which span eclectic computing areas such as software engineering, data science, user experience design, etc. Industry employers hire interns and full-time employees for these roles through a multi-stage competitive recruitment process [106, 152]. The process typically has three stages: an application phase, an interview phase, and a negotiation phase. During the application phase, an applicant applies to various roles and companies by submitting their resumes and answering questions on digital applications, career fairs, or company information sessions. The applications are screened, and candidates are selected for the next stage which is the interview phase based on a student's experience, GPA, and involvement in projects [152]. Companies invite applicants for one or more technical and behavioral interviews and there is variation in the number and rigor of the interviews depending on the job role and companies. A majority of companies ask students technical questions in an interview related to DSA, especially for software development and engineering positions. Finally, in the third stage, an offer is made by the company, and the applicant has an opportunity to negotiate. Our intervention focuses on preparing students for the interviewing phase of software development and engineering jobs given their prominence and the overlap with our DSA course. Research on these technical interviews in computing industry spans three areas in literature:

5.2.1 Employer-centric Research on Structure and Expectations in a Technical Interview

Work that explored expectations of employers in a technical interview includes Ford et. al's work [51] on interviewers' expectations from potential software engineer candidates. They found that interviewers were not only interested in the technical problem-solving ability of the candidates, but also the interpersonal skills such as effective communication skills. Another work assessing the structure of technical interviews by Stepanova et. al. [152] found that recruitment professionals reported differences in interview structure across companies with variations in components like coding tests, on-site interviews, team interviews, or behavioral interviews. However, it is evident from the aforementioned studies that technical interviews are used as a primary recruitment tool for securing jobs in the computing industry. Given that not all students have a considerable amount of time to prepare for these interviews outside the curriculum [76], we wanted to introduce an intervention that can provide preliminary exposure to technical interviews to our students.

5.2.2 Student-centric Research on Interview Participation and Factors that Influence Success

Studies have also explored student participation in technical interviews and factors that promote or hinder success in the interviews. This work includes Wyrich et al.'s study [169] which identified the individual characteristics of students' performance in solving coding challenges and found that students who completed coding challenges had higher grades, more programming experience, and higher happiness. Lunn et. al. [103] observed similar results and found that students who had more coding experience had positive experiences with technical interviews and a higher computing identity. Another example is Hall and Gosha's study [63] which identified African American students' participation in technical interviews and found that interview performance decreased with increasing anxiety and the anxiety decreased as students participated in more interviews. Other studies [12, 49] have also found that interviewees participating in technical interviews have experienced stress and anxiety which prohibits their performance. In short, these interviews can be stressful, and higher participation may yield better outcomes. So why not use supplementary formative activities in coursework to help students feel more confident in their ability to excel in technical interviews? We aim to abate these issues through our activities.

5.2.3 Practitioner-centric Research on Designing Interventions for Interview Preparation

A few interventions have been introduced in computing classrooms [49, 160] or through academic-industry partnered programs [2] which were intended to prepare students for technical interviews. These include Urness's work [160] on the introduction of technical coding exercises in a CS2 course in the form of programming assignments. However, this intervention focused on individual problem-solving akin to a coding test which is seldom a precursor to an actual technical interview [51]. Another work by Dillon et. al. [49] incorporated and evaluated the efficacy of the inclusion of coding exercises in CS2 and Object-Oriented Programming courses where students were assigned into groups of three and asked to think aloud and explain solutions using Zoom breakout rooms to their peers. They found that students received the activities positively but still showed adequate levels of anxiety. The latter intervention was introduced in a smaller course and the interview questions were provided by the instructor for the group. The setup did not consist of dyads with an interviewer and interviewee role. Our intervention is different from this intervention as we tried to mimic the more prevalent dyad interview format, and we present how to scale our activities in large classrooms using a peer interview approach.

5.3 Settings

5.3.1 Educational Institution

Our intervention was introduced in a DSA course at the University of Florida in the fall of 2020. At the research site, admission in undergraduate degree programs is competitive and participation in industry internship(s) before graduation is not mandatory. Our DSA course is a required course for CS and Computer Engineering majors and CS minors. It follows the CS1, CS2, and Discrete Mathematics courses and students have prior knowledge of programming in C++ and Java. 250-450 students enroll in the course in spring and fall and 100-150 in the summer. For this study, we use data from 257 students who consented and participated in our intervention in fall 2020 and 106 students who were enrolled in summer 2020 in our course and did not participate in our activities (control group).

5.3.2 Course Structure and Content

Our course covers different DSA-related topics such as Algorithm Analysis, Sets, Maps, Trees, Graphs, Greedy Algorithms, etc. The language of instruction is C++, and the course has an equal mix of theory and practice. For the latter, students solve short programming DSA problems on a browser-based system and work on projects. The course was worth 4 credits in summer and fall 2020 and students had to attend three lectures led by the instructor and one discussion every week led by a peer mentor or teaching assistant. The course lasts 15 weeks in fall and 12 weeks in summer. In both summer and fall 2020, the course was online due to Covid-19, was taught by me, and followed a hybrid format structurally consisting of two remote synchronous lectures and discussion and two remote asynchronous pre-recorded lectures. Students were tested on weekly quizzes, two individual projects, a final ill-structured and self-proposed group project, and two exams in both semesters.

5.4 Intervention Logistics

Our technical interview exercises were designed after taking input from the students in Week 2 of the fall 2020 intervention semester. In the second week of our course, we added a few optional ungraded questions to the first quiz which asked students about their familiarity with technical interviews. Most students (58% or 143 of the 248 students who answered this question) were not familiar with the technical interviews. Quite a few students (30% of 248, n=75) were familiar with technical interviews but had not participated in them. The remaining students had participated in a technical interview but failed to secure an internship (6%, n=14), cleared a technical interview and had interned (6%, n=14), or were not interested in computing careers (2%, n=5). Three students selected more than one statement and hence the numbers don’t add to 100%. Since the awareness of the technical interview process was quite low, we decided to incorporate two activities: a panel and a role-play exercise conducted by the peer mentors and TAs before asking students to participate in mock interviews (see Figure 5-1).

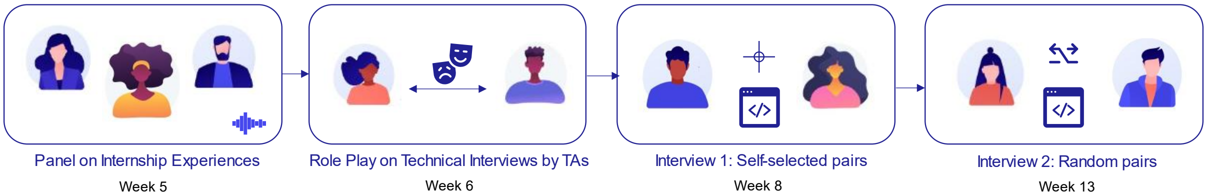


Figure 5-1. Logistics of embedding Hire Thy Gator technical interview activities as reported in Kapoor et al. (SIGCSE 2023)

5.4.1 Panel

The first activity was a panel hosted in Week 5 of our course. The goal of the panel was to make students aware of the importance of internships and introduce them to the recruitment process. The panel consisted of four undergraduate peer mentors (TAs) and was moderated by the instructor. All four TAs had worked as interns in top tech companies in the US such as Alphabet and Microsoft. The panel revolved around the technical interview process, former participation experiences, and the strategies TAs used for successfully securing an internship. This panel was conducted outside of course hours and lasted 45 minutes.

5.4.2 Role Play Demonstration

The second activity consisted of a role-play demonstration which was organized in Week 6 of our course. During this exercise, the TAs role-play acted as an interviewer and an interviewee in a weekly discussion session to show students what they could expect in a technical interview. We emphasized an iterative approach to solving a problem and underscored the importance of asking follow-up questions as well as writing pseudocode or explaining the solution in words before writing actual code. We also highlighted that interviewer can provide hints if the interviewee is stuck for too long. The role play exercise ended with a conversation between the interviewer and interviewee reflecting on the strengths and weaknesses of the interviewee and how an interviewee can improve. Although the latter conversation is not a part of an actual technical interview, we wanted student interviewers to understand how to conduct a discussion after the mock interview for providing constructive feedback to the interviewee. The reflection and feedback components were added as our activities are formative and the feedback can better prepare students for subsequent interviews. The peer mentors spent three hours preparing for this exercise and the actual class discussion session lasted another 50 minutes.

5.4.3 Mock Interviews

After the role-play demonstration, students were asked to work in pairs for two mock interviews in the middle of the semester (Week 8) and the second-last week of the course (Week 14). In the first mock interview, students were allowed to self-select peers with whom they wanted to work. If they could not find a partner, the matching was facilitated by the instructor. In the second mock interview (Week 14), we randomly paired them with another student. This allowed us to scaffold the social interaction of the students and reduce the interview anxiety which is common in technical interviews [12, 49]. In each activity, the students were asked to interview each other with every student acting as an interviewer and an interviewee. We wanted students to act as an interviewer so that they can gain exposure to the recruitment side. In addition, we wanted to make the activity scalable for large classes where the course staff does not have enough resources to interview each student individually. This setup allowed minimal resources with the necessary benefits of exposure to a technical interview.

The activity descriptions were created on our learning management system (LMS), Canvas. Each student was asked to fill out two graded survey assignments for each round of interviewing: one as an interviewee, and another as an interviewer [87].

To help students prepare as an interviewee or an interviewer, we also provided optional resources in survey descriptions such as YouTube videos from Google on what interviewers seek out from candidates in a technical interview or from Gayle McDowell, the author of Cracking the Coding Interview [106] on how to approach technical interviews. The descriptions also consisted of links to two sample interview questions.

The assignment descriptions also had instructions for the interviewer and interviewee. Interviewers were asked to (1) research the question they were going to ask the interviewee, (2) coordinate the time, (3) record the interview and keep track of the solution document, (4) give the interviewee hints if they are stuck for too long, and (5) provide actionable feedback to the interviewee reflecting what were the strengths of the interviewee and what can the interviewee improve on. We asked interviewers to record the interview using Zoom and provide the candidate with a Google document link to write the solution. We also suggested to the interviewer a 40-45 minute window for the technical interview and a 15-20 minute post-interview session on giving actionable feedback to the interviewee. If students spent less than 20 minutes on the activity, we required them to ask an additional technical question or conduct the activity again. For the first set of interviews, interviewers were supposed to pick a question on Trees or Heaps, and for the second one on Graphs or Sets and Maps which are common topics that are covered in technical interviews [106]. This alignment was based on the topics covered in our course during respective times. After the interview, the interviewer was supposed to fill out a survey where they entered a link to the recorded interview, the solution document, and a few reflection questions on their as well as the interviewee’s performance. They were also asked for feedback on our activity.

The interviewee’s assignment had a description of their responsibilities. They did not know the question beforehand, but they knew that the interviewer would ask questions about the covered topics. The interviewees were told to walk through their approach to solving a problem before coding the solution, ask questions to clarify constraints, improve their solution iteratively, and walk through their solution with a test case to identify any possible bugs. After the activity, the interviewees reflected in the survey their strengths and weaknesses and their experience in the activity. Instructors can find all relevant materials to incorporate our exercises here [87].

The mock interviews were graded based on participation and carried 8% of the points of the final grade (2% for acting as an interviewee and 2% for being an interviewer for each activity). Students (N=257) self-reported average time for preparation and participation in the interview was 2 hours for acting as an interviewer and 1 hour 52 minutes as an interviewee per activity.

5.4.4 Time Requirements

To sum up, practitioners replicating the technical interview preparation activities can expect to utilize 6 hours of fixed time to introduce these activities. This time includes 1 to 2 hours of course instruction time for conducting the panel and role-play demonstration and 1 to 4 hours of preparatory time for setting up and organizing the activities. Additionally, variable time spent would cost another 1 to 2 minutes for grading each student submission per activity. The latter time would be more if an instructor wants to provide personable feedback to each student.

5.5 Lessons Learned for Logistics of Subsequent Activity Offerings

5.5.1 Pairing Facilitation

A problem that quite a few students (approximately 15-20%) faced was a lack of communication and scheduling issues with their assigned partner. We received several messages on our discussion tool regarding these issues which are an overhead, especially in large classes. We mitigated these problems by assigning a new partner who had a similar issue. In hindsight, we should have provided two deadlines for each interview activity: (1) communicate with the partner and set up the time for the interviews, and (2) the deadline for the actual interview and deliverables.

5.5.2 Alternate Assignment for Students Interested in Careers Other Than Computing

4% of students did not participate in the interview activities. The instructor reached out to these students asking if they wished to justify why they didn't participate and offered them an alternate assignment as it had a non-trivial impact on student grades. Five students responded that they did not participate because of social anxiety, lack of interest in CS jobs, or lack of time. For instance, a student stated, "*There were a few reasons I didn't complete the assignment, the main ones being my social anxiety/difficulty interacting with people I don't know [...] and that I am not expecting to look for/apply for a job in this field*". The students who did not participate were given alternate coding problems. We recommend other instructors offer alternate activities for such students.

5.5.3 Reduction in Grading Weights to Account for Time

Our assumption was students would spend 7 to 8 hours preparing and participating in each round of an interview for both roles. However, the self-reported time spent was less than we anticipated, and students spent on average 4 hours per interview. Hence, in subsequent iterations of the course, the grading structure was reevaluated to account for the time spent and the grading percentage was reduced from 8% to 5% for participating in the two activities.

5.6 Evaluation Methodology

5.6.1 Study Design

Our study uses a survey based retrospective post then predesign [133]. In this design, a survey is disseminated at the end of an educational activity or program, to gauge a participant's change in attitudes, knowledge, or confidence. Data is collected only once, and participants state their confidence level at the end of an activity (post) and retrospectively gauge their confidence level at the beginning of the activity (pre). This type of study avoids pretest sensitivity and response shift bias that result from pretest misestimation. Response shift bias occurs when participants use different frames of understanding about a question between pre and post intervals [71]. Prior studies have shown higher validity of this design than a traditional pre and post design when comparing results with interview data and hence this design was chosen [185] To evaluate our intervention, we use data from a research survey disseminated at the end of control and intervention semesters and interview reflection surveys which were completed by the students after each of the mock interviews. Through our evaluation, we seek to answer the following research questions:

- **RQ1a.** What do undergraduate computing students gain from participating in mock interview exercises?
- **RQ1b.** How does participation as an interviewer differ from participating as an interviewee?

- **RQ2.** How does participation in technical interview preparation activities influence students' perceived confidence levels for programming in a technical interview?

5.6.2 Study Participants

Our study was approved by the Institutional Review Board at the University of Florida. 345 students were enrolled in our course in fall 2020 and 279 students consented to the study (Response rate: 80.9%). Of the 279 students, 22 students' data were discarded due to missing data. Thus, our intervention corpus consists of 257 students. In addition, 143 students enrolled in our course in summer 2020. The data from this cohort was used as a control group as our activities were introduced after this semester. For summer 2020, 115 students consented to research (Response rate: 80.4%). Our control group corpus consists of data from 106 students after deleting missing values. Participant demographics are shown in Table 5-1 and Table 5-2 and gender proportions in our sample are representative of the student population enrolled in the CS/CE degree program at our institution.

Table 5-1. Demographics of students who participated in our study as reported in Kapoor et al. (SIGCSE 2023)

Term	Academic Standing (By Year)					Gender		
	1	2	3	4	5-6	Male	Female	DWTS*
Control, N = 106	8%	37%	41%	10%	4%	76%	24%	-
Intervention, N = 257	0.4%	62%	26%	10%	1.6%	71%	28%	1%

* Did not wish to specify

Table 5-2. Students' major who participated in Study 3

Term	Major			
	CS	CE	CS Minor	Others
Control, N = 106	67%	15%	7%	11%
Intervention, N = 257	66%	18%	10%	6%

5.6.3 Data Collection

In this study, we use data collected from a post research survey during the control and intervention semester (for answering RQ1a and RQ2) as well as student reflections which were a part of the technical interview deliverables collected during the intervention semester (for answering RQ1b). On average, students spent 22 minutes filling out the research survey which asked them questions on demographics, professional identity, the efficacy of professional development intervention, and how they prepare for technical interviews outside of coursework. The questions we use from these instruments in this section and how they map to our research questions are described in Table 5-3.

5.6.4 Data Analysis

To answer RQ1a (*What do undergraduate computing students gain from participating in mock interview exercises?),* we coded open-ended responses using inductive content analysis [21] to identify the affordances for our activities using student perspectives. We supplement our exhaustive codes with representative quotes to demonstrate what students gained from our activities.

For answering RQ1b and RQ2, we took a quantitative approach. For RQ1b (*How does participation as an interviewer differ from participating as an interviewee?*), we coded five-point Likert scale statements for four metrics (self-confidence, familiarity, self-evaluation, and usefulness) to 0-4 and then applied nonparametric statistical tests to determine significance of our results across the population of undergraduate students. A two tailed Wilcoxon Signed-Rank Test for paired samples was used as our data did not follow a normal distribution (as identified through a Shapiro Wilk test). Alpha was set to 0.05. The null hypothesis for these tests asserts that the medians of the two samples are identical. For example, one of our null hypotheses was: *There is no difference between the median students' reported confidence gain when participating as an interviewer and an interviewee in the technical interview preparation activities.*

Similar hypotheses were used for gauging if participating in our activity increased students' familiarity with the technical interview process, supported self-evaluation, and were overall useful for future success for each role.

Table 5-3. Mapping of collected data and research questions for Study 3 as reported in Kapoor et al. (SIGCSE 2023)

Research question	Survey question	Question Type/Scale
RQ1a. What do undergraduate computing students gain from participating in mock interview exercises?	1. How was your experience in Hire Thy Gator Interview Exercises? Should they be a part of future course offerings?	Open ended
RQ1b. How does participation as an interviewer differ from participating as an interviewee?	1. Acting as an interviewer increased my *self-confidence* to succeed in a technical interview in the future[#]. 2. Acting as an interviewer increased my *familiarity* with the technical interview process[#]. 3. Acting as an interviewer is a *useful activity* that is beneficial for me to succeed in a technical interview[#]. 4. Acting as an interviewer allowed me to *understand my weaknesses and strengths* to succeed in a future technical interview[#].	5-point Likert scale: Strongly disagree (0), Disagree (1), Neither disagree nor agree (2), Agree (3), Strongly agree (4)
RQ2. How does participation in technical interview preparation activities influence students' perceived confidence levels for programming in a technical interview?	1. How confident were you with your ability to program in programming interviews before the starting of this course?* 2. How confident are you with your ability to program in programming interviews at the end of this course?*	5-point Likert scale: Not confident (0), Slightly confident (1), Moderately confident (2), Confident (3), Extremely confident (4)

The above questions were repeated to gauge students' perspective on participation as an interviewee (e.g., Acting as an interviewee, increased my *familiarity* with the technical interview process).
* These questions were included in the survey presented to the Intervention and Control groups. All other questions were asked to participants of the intervention cohort.

For RQ2 (*How does participation in technical interview preparation activities influence students' perceived confidence levels for programming in a technical interview?*), a two-tailed Mann-Whitney U Test was conducted to evaluate differences in pre- and post-data from independent samples as our data did not follow a normal distribution. The null hypothesis for these tests asserts that *the median pre or post students' confidence levels of the two samples (control and intervention) are identical* and a p-value < 0.05 was used to reject the null. Additionally, we used a confidence gain metric similar to Hake's learning gain metric [38, 61, 62] as there was a significant difference between the pre-confidence levels of our control and intervention cohorts. The confidence gain metric would account for cohorts that may have higher confidence than others when they begin the semester, and it was computed as:

$$\text{Average normalized confidence gain}, \langle g \rangle = \frac{\langle \%\ \text{Post} \rangle - \langle \%\ \text{Pre} \rangle}{100\% - \langle \%\ \text{Pre} \rangle} \tag{5-1}$$

where, <% Post> and <% Pre> measures are the final and initial course averages of self-reported confidence computed as a percentage. Our confidence gains are computed at a classroom level (gain of averages method, [61, 110]).

5.7 Results and Findings

5.7.1 Affordances of Hire Thy Gator Technical Interview Activities (RQ1a)

To answer RQ.1a. (What do undergraduate computing students gain from participating in mock interview exercises?), we asked students in a survey at the end of the course, "How was your experience in Hire Thy Gator Interview Exercises? Should they be a part of future course offerings?". 257 students answered this open-ended question, and we categorized their responses using inductive content analysis [21] to identify affordances and benefits of our activities as well as explore students' preferences for continuation of our activities.

Students who participated in our Hire Thy Interview technical activities described that mock interviews impacted them in different ways. The affordances of the activities from students' viewpoint were categorized into nine exhaustive codes. These codes were: (1) awareness of the technical interview process, (2) preparation for future technical interviews, (3) motivation to apply for internships/jobs, (4) opportunity for applying the coursework more practically, (5) building students' confidence, (6) reducing anxiety/fear, (7) providing a low stakes environment, (8) scaffolded interview practice and (9) self-evaluation of one's strengths and weaknesses. Representative quotes on each of these affordances are shown in Table 5-4.

Regarding continuation of our activities in future semesters, 91.8% of the 257 students (n=236) described our exercises positively stating that they should be continued in the future offering of our course as-is or with minor modifications. For instance, S11 described the intervention as "*a great experience because it gave [her their] first glimpse of an actual industry interview setting*". She added that "*they should be a part of future course offerings*". 6.2% of the 257 students (n=16) had a negative experience with our exercises and stated that the interviews should be discontinued in the future, or students should have an alternate activity to participate in. One such student was S11 who stated that the interview exercises "*are a good idea in concept, but perhaps don't have a great place in the course. It is overly awkward and not overly helpful in making students better at technical interviews*". 2% of the 257 students (n=5) were neutral about their inclusion and reported that it did not impact them. For example, S56 reported,

> They really have no impact on me as a CS minor. I feel that for the majority of the class (CS(E) majors) they are helpful. I am not sure on how that could be dealt with in future courses.

Table 5-4. Affordances of mock interviews and representative quotes

Affordance (Codes)	Representative Quote
awareness of the technical interview process	"I believe that the [interview] exercises were important in getting familiarised with the programming interview process. This is especially true for people like me who had never done a live programming interview before".
preparation for future technical interviews	"I think it was really useful and prepared me well for interviews in the future".
motivation to apply for internships/jobs	"The [interview] exercises taught me alot about what to expect in a technical interview. Usually I use my portfolio to get [me] small jobs freelance, but a full scale interview got me very excited to someday do an internship."
applying the coursework more practically	"These were really good for contextualising our course content with something that is very relevant to all of us looking for jobs and internships".
building students' confidence	"The [interviews] massively improved my confidence for interviews."
reducing anxiety/fear	"I think these should be continued as they are great for people like me who have never touched anything remotely close to a technical interview. I think it takes away the uncertainty and fear of these interviews to an extent as it also lets you collaborate with classmates and see their point of views as well."
providing a low stakes environment	"[Interview] activities helped me feel more prepared for job interviews and were a relatively low stress manner to practice without too much time commitment. For that I appreciated them."
scaffolded interview practice	"The way it's laid out with you being able to do it with a friend for the first time and then with a stranger is also useful. It's really made me a lot more comfortable with coding in front of others. It should definitely be kept."
self-evaluation of one's strengths and weaknesses	"I liked them and they revealed things I need to work on before I do another technical interview."

5.7.2 Efficacy of Role in an Interview (Acting as an Interviewer vs Interviewee RQ1b)

We were also interested in understanding the impact of interview roles on students' perception of the efficacy of our activities. To compare the impact of these roles (interviewer and interviewee) and answer RQ1b (*How does participation as an interviewer differ from participating as an interviewee?*), we quantitatively determined student responses to four Likert scale measures which were collected in graded surveys for each mock interview and each role. These statements (see Table 5-3) asked students to rate the contribution of a role (interviewee or interviewer) on (1) increasing self-confidence, (2) improving familiarity, (3) affording self-evaluation, and (4) deeming usefulness of the activity for future success in technical interviews. Students agreed or disagreed with the statements using a 5-point Likert scale (recoded 4 - Strongly agree, 0 - Strongly disagree).

In general, students' average ratings on the contributions ranged from 3.06 to 3.54 out of 4.00 indicating agreement or a strong agreement for each of the roles and for each activity (see Table 5-5). We also observed that **students perceived participating as an *interviewee* had higher value than participating as an *interviewer* for** each of the measures for both activities. For **two metrics, self-evaluation and usefulness**, the results were statistically significant ($p < 0.05$) for both rounds of interviewees and we rejected our respective null hypothesis. This indicates that students' perceived participation as an interviewee yielded a better mechanism to self-evaluate one's strengths and weaknesses and is considered more useful for future success in technical interviews than acting as an interviewer. For one metric, increasing familiarity, we failed to reject the null hypothesis for both activities indicating that students' perceived participation as an interviewer or an interviewee offered comparable familiarity with the technical interview process. For the last metric, increase in self-confidence, results were significant for round 2 of interviews while not significant for round 1. This means that participating as an interviewee or an interviewer may or may not have equal benefits of increasing confidence and further evidence is required to make a stronger claim. Qualitatively, students mentioned in their responses that participation as an interviewer also has value as they gained insight into tips and expectations for subsequent interviews and alternate ways to solving a problem which they did not gain from participation as an interviewee.

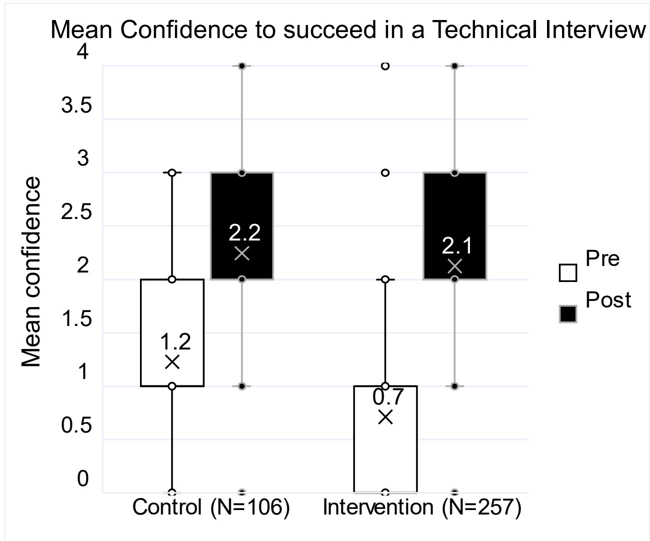
Table 5-5. Impact of Hire Thy Gator activities on interviewers and interviewees (N=257)

Activity	Metric	Mean Likert Scale Rating (0-4) Interviewer (a)	Mean Likert Scale Rating (0-4) Interviewee (b)	**δ**(b-a)	Wilcoxon Signed-Rank Test	
					Z	p-value (**α** = 0.05)
Interview Round 1	familiarity	3.44	3.49	0.05	1.2	0.23
	self-evaluation	3.23	3.46	0.23	5.1	< 0.001*
	usefulness	3.32	3.52	0.20	4.9	< 0.001*
	self-confidence#	3.06	3.11	0.05	1.4	0.15
Interview Round 2	familiarity	3.46	3.48	0.02	0.6	0.53
	self-evaluation	3.23	3.52	0.29	6.1	< 0.001*
	usefulness	3.37	3.54	0.17	4.4	< 0.001*
	self-confidence#	3.15	3.27	0.12	2.9	0.004*

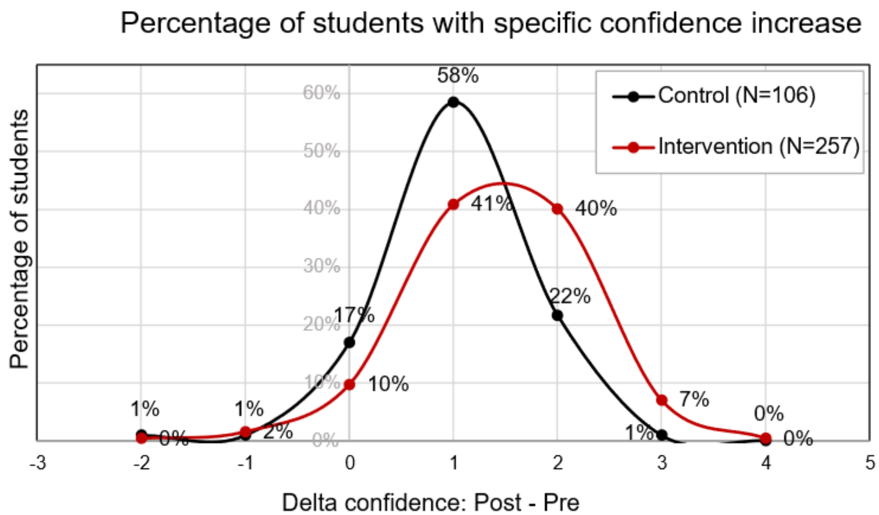
N = 256 as one paired data point was missing and ignored
* Statistically significant, p < 0.05
~ 0: Strongly disagree and 1: Strongly agree

5.7.3 Efficacy in Building Confidence

To evaluate the efficacy of our interview preparation activities on building students' confidence and answer RQ2 (How does participation in technical interview preparation activities influence students' perceived confidence levels for programming in a technical interview?), we asked students to gauge their confidence in their ability to program in technical interviews before and after the course in both cohorts. We hypothesized that participation in our activities would improve students' confidence. However, there was a difference in the pre-confidence levels of our control and intervention cohorts.



A



B

Figure 5-2. Efficacy of Hire Thy Gator activities for developing confidence in students. A) Box plots of Students' aggregate confidence across cohorts. B) Change in confidence levels between pre and post for the two cohorts.

The mean confidence reported at the start of the semester (pre) by the students in the control group was 1.2 (on a scale of 0-4) while that of the intervention cohort was 0.7 (see Figure 5-2 A). This difference was significant ($Z = 4.9$, $p < 0.001$). The students in the control group were enrolled in the first semester post the onset of Covid-19 and most students were not participating in internships because of the pandemic. The higher confidence scores could be because of the fact that students had less fatigue, and these levels were an anomaly compared to subsequent semesters. However, since we introduced the intervention and students reported significant benefits of the activities, we would prohibit students from the benefits of these activities if we were to reevaluate the efficacy using a new control group. This may violate the educational equipoise principles [65] and hence we recommend researchers who have not offered these activities to verify the efficacy of our activities. There was no significant difference in post confidence levels between the control ($Postsummer_{2020} = 2.2$) and intervention ($Postfall_{2020} = 2.1$) group, $Z = 1.47$, $p = 0.14$ suggesting that the post confidence levels were almost similar for both cohorts.

Since there was a difference between the two cohorts' pre-measures, we computed the average confidence gain of the intervention and control cohorts. The overall average confidence gain of the control semester cohort was 0.36 while that of the intervention semester was 0.42. The change in confidence levels is shown in (see Figure 5-2 B). It is evident from this figure that during the intervention semester, a higher percentage of students had a greater boost in confidence levels (40% of students had a 2-point jump in the intervention cohort compared to 22% of students in the control cohort and 7% of students had a 3-point jump in intervention cohort compared to 1% students in control cohort). This difference in confidence gains could either be attributed to our interview activities or graded programming problems. Nevertheless, the increase in confidence gains and student recommendation on the usefulness of our activities is promising.

5.7.4 Rooms for Improvements in Our Activities

The 8.2% of 257 students (n=21) who stated that these activities should be discontinued or those who mentioned improvements in future offerings of the mock interview exercises highlighted the challenges associated with our activities. 76% of these 21 students (n=16) who didn't like the exercises mentioned that they were not CS majors and were not interested in computing jobs. For instance, S318, stated "*I didn't prepare for them seriously because as an accounting major, I will not undergo technical interviews to get a job. I think they are very valuable for computer science majors".*

Some students also mentioned that the exercises were stressful for them and demanded too much time. Other rooms for improvement were primarily logistical. Students recommended to give them an interview question list from which they can pick a question, allow using text editors instead of a Google doc, make them do exercises as a part of extra credit and not a part of their course grade, reduce the interview time length requirement, add a segment on behavioral questions apart from the technical ones, and match the partners based on skill levels.

We recommend Instructors provide alternative exercises for students who may not be interested in technical careers. Further, we invite researchers as well as system designers to build systems or processes for better pairing students for mock technical interviews based on their competencies.

5.8 Discussion and Conclusion

In conclusion, we presented the implementation and evaluation of our technical interview activities, adding to the computing education research literature rich descriptions of our pedagogical activities and empirical results regarding its' efficacy. While prior work has focused on incorporating coding exercises in the curriculum to prepare students for technical interviews [160], our work provides an intervention that is closer to an actual technical interview. Moreover, our formative activities can be used as scalable collaborative assessments in large classrooms with minimal time overheads. Similar to prior work which reported that students find interviews stressful and anxiety-inducing [12, 49], we also observed a few students describing that the interviews were stressful. However, our activities were graded based on participation and not correctness and we introduced measures to scaffold the social anxiety such as allowing them to self-select partners in the first round of interviews. Regarding evaluation, the activities were well received, made students aware of the recruitment process, and suggested agentic development in students offering them an avenue to self-evaluate and develop confidence to secure a future internship.

Therefore, we recommend other instructors introduce these exercises, especially in DSA courses given the overlap with course content. Also, we recommend the instructors to give students alternate exercises who are not interested in pursuing a computing career. In the future, we will determine the efficacy of our exercises for securing actual internships by retrospectively gauging student opinion regarding the value of our activities beyond the course.

5.9 Limitations

To evaluate our activities for confidence building, we compare data from the intervention semester with a previous semester’s data. Both cohorts were taught by the same instructor. There were however two differences between the offerings. Both changes pertained to the grading structure, but the course content was the same. First, we introduced graded participatory coding exercises. The problems were available to the students in the control group, but they were optional. However, in the intervention term, students could receive 5% points if they attempted 21 or more of the 55 problems. This change in the grading rubric was based on the control cohort's feedback which mentioned that students were spending significant time on these problems and found them useful for interview preparation. Second, we introduced the mock interview exercises which carried 8% points of final grades. Hence, to account for students' time on our formative activities, we made room in the grading rubric for the intervention cohort. 2-3% points were reduced from other assessment grade weights. The scope of these assessments was adjusted to make up for the increased workload. Our assessment of the intervention for building confidence could be attributed to a combination of the two activities (graded short programming problems or mock interview exercises) which pertained to technical interview preparations. In the future, the efficacy of the activities can be assessed in isolation through more structured quasi-experiments.

5.10 Lessons Learned for Subsequent Studies

Our activities exposed students to technical interviews and developed confidence in them for succeeding in future technical interviews. However, we have not analyzed empirically the efficacy of our activities in aiding students to secure actual internships after our intervention. I did receive several unsolicited emails from students in subsequent semesters that our activities and course helped them in securing internships. For instance, students stated that

> I found the Hire Thy Gator exercises to be incredibly helpful and that [the Instructor - I] and the TA's went above and beyond to prepare students for interviews and industry. Particularly, [TA-anon1] and [TA-anon2] gave me incredible advice and I just accepted a great software engineering internship for this summer!.

> Thanks to your teaching, I was able to successfully answer a technical question at career showcase. [This] resulted in an offer for an interview from the company!

> I took your class, Data Structures & Algorithms fall 2020 which I thoroughly enjoyed! [...] Your encouragement and preparation for technical interviews for our careers was one of the best outcomes I’ve ever had from a course!.

To systematically understand the efficacy of our activities in helping students secure internships in our population, we conducted a retrospective survey based empirical study which will be described in the next chapter. The results from this study corroborate or refute our anecdotal evidence.

CHAPTER 6
STUDY 4: HOW EFFECTIVE IS OUR PEDAGOGICAL INTERVENTION IN PREPARING STUDENTS FOR SECURING INTERNSHIPS?

To prepare students for technical interviews and help them secure internships and full-time jobs, we introduced Hire Thy Gator technical interview preparation activities (see Chapter 5), in a large DSA course to 3,526 students over 12 consecutive semesters which I taught. In the previous chapter, I described how we investigated the efficacy of our activities in preparing students for the employment recruitment process immediately after their participation. However, since this evaluation was right after student participation, they may not have the opportunity to apply for actual employment opportunities and hence the efficacy of our activities to help students secure actual internships and jobs remain unknown.

This chapter presents results from a retrospective survey-based study in which 512 students evaluated our activities one to twelve semesters after their participation. We investigated: (1) students' ability to recall participation, (2) their perceptions of our activities' impact on metrics such as familiarity with interview process, self-confidence, etc., (3) the influence of activities on subsequent preparation practices and applying actual internships/jobs, and (4) the role of these activities in securing employment.

Since the background and related work relevant to this chapter are similar to those detailed in the previous chapter, I will not repeat them. Readers are encouraged to refer to Chapter 5 for a comprehensive discussion of the foundational concepts and related studies. Data from this study was submitted to a peer-reviewed conference and the paper entitled, "*Retrospective Evaluation of Technical Interview Preparation Activities offered in a Data Structures and Algorithms Course*" was accepted to be a part of the upcoming proceedings of the 30th annual ACM conference on Innovation and

Technology in Computer Science Education (ACM ITiCSE 2025). I am the lead author on this paper and Dr. Gardner-McCune was the supervisor and co-author.

6.1 Overview

Most employers recruit students and recent graduates for computing internships and jobs using technical interviews [106, 152]. These interviews are used by employers as an assessment tool to gauge students' technical and professional skills [152]. The interviews often require students to solve technical problems that cover data structures and algorithms (DSA), or system design [106]. However, students often report that these interviews are challenging, stressful, and anxiety-inducing [10–13, 43, 63] and they having a hard time preparing for these interviews with the extensive workload of degree programs [13, 76]. The latter challenge is especially experienced by underrepresented students in computing [101–103, 106] or students of low socioeconomic backgrounds who have to juggle part-time work or family responsibilities with their program workload [76]. As these interviews often determine career opportunities, preparing students to succeed in them is a critical component of computing education, especially since most undergraduate computing students have a professional goal of securing a job after graduation [78].

To address this challenge of preparing students for technical interviews, we developed Hire Thy Gator technical interview preparation activities consisting of mock interviews and implemented them in a large DSA course which we presented in the previous chapter. We evaluated the reception of these activities by comparing key results between a control and intervention group using a survey-based study that was implemented immediately after student participation in our activities [85, 88]. In this chapter, we present findings from a new survey-based study in which 512 students retrospectively evaluated the efficacy of our activities one to twelve semesters after their participation and potentially with additional experience gained through the internship or job recruitment process.

The central research question that we aim to answer is "*How effective are Hire Thy Gator Technical Interview Exercises in preparing computing undergraduate students to secure industry internships or full-time jobs*?". Our results from this study complement the findings of our previous work [85, 88], providing a comprehensive overview of the efficacy of our activities on the employment outcomes of students.

We found that 74% of the 512 students were able to recall our activities. Most students reported that our activities increased their familiarity and self-confidence, provided an opportunity to self-evaluate, and motivated and prepared them for subsequent interview practice or to apply for internships/jobs. However, the students noted that the activities alone were insufficient to secure employment. Nevertheless, they found our activities useful and proposed their continuation. Our work contributes an empirical retrospective evaluation of an intervention that has implications for improving student employment outcomes.

6.2 Methods

6.2.1 Institution and Course Context

Our *Hire Thy Gator technical interview preparation activities* intervention was implemented in a large DSA course over twelve consecutive semesters (fall 2020-summer 2024). I was the lead Instructor for this course, and it was offered at a large public university, the University of Florida. Each semester, the course enrollment varies between 250-600 students in the spring and fall terms (~15 weeks), and 100-200 students in the summer term (~13 weeks). Additional details about the institution and course are described in Section 5.3.

6.2.2 Intervention

Our *Hire Thy Gator technical interview preparation activities* consisted of typically three activities:

1. a panel on internship experiences in Week 5 of the course.
2. role-play demonstration by the TAs on how to conduct a technical interview in Week 6 of the course.
3. one or two mock interviews with a self-selected partner (in Week 8), and a random partner (in Week 13).

These activities are described in detail in Chapter 5 (Section 5.4 and Figure 5-1). Regarding mock interviews, students were asked to work in pairs for one or two mock interviews. The variance in the interviews was due to student feedback that they preferred one interview instead of two due to the excessive workload. Between fall 2020 - fall 2022, students participated in two mock interviews (one self-selected and one random partner), while since spring 2023 they participated in one mock interview with a random partner. Additionally, the weeks when students were asked to interview each other in the summer semester were accelerated due to a shorter summer term. As part of each interview, the students assumed the roles of both interviewer and interviewee. This dual-role approach was designed to provide students with insight into the recruitment process from the interviewer's perspective. Additionally, this structure allowed the activity to be scalable for large classes, where course staff may not have the resources to conduct individual interviews for every student. The mock interviews were graded based on participation as part of one or two weekly programming quizzes which were used as assessments in our DSA course.

6.2.3 Study Design and Research Question

To understand the efficacy of our activities in supporting students prepare for technical interviews or secure actual internships/jobs over the long term, we designed a longitudinal panel survey study [42]. In this design, data are examined from a specific cohort(s) of participants over time. We chose this design as we assessed the perception of efficacy of our activities on the student cohort who were exposed to our intervention. Students retrospectively evaluated the role of our activities in supporting them for (a) future technical interview preparation, and (b) securing an internship or job during their undergraduate program one to twelve semesters after their participation in our activities. In this study, we aim to answer the following research question (RQ): "*How effective are Hire Thy Gator Technical Interview Exercises in preparing computing undergraduate students to secure industry internships or full-time jobs?".* We further explore this RQ using several dimensions as described in Table 6-1.

6.2.4 Survey Population and Sample

The sample for our survey is drawn from the population of undergraduate students who participated in our activities in a DSA course that was offered at a large public university in the US from fall 2020 to summer 2024 (12 semesters). Our target population consists of 3,526 students who were enrolled in the DSA course and submitted course evaluations after the final withdrawal period. It excludes students who dropped our course (~12%) and multiple count of students who did not earn a passing grade (~ 7%) and may have retaken the course. Of these 3,526 students, 512 students completed our survey and are part of our sample (Response Rate: 15%). These students identified their gender identities as males (64%), females (30%), others (1%) or they did not specify their gender (5%) representing the population of students in our

CS program. Most students in our sample were in Year 4 (47%), followed by Year 3 (35%), Year 5-6 (9%), Year 2 (6%), and others (1%) in our program.

Table 6-1. Sub research questions and survey questions mapping for Study 4

RQ.	Dimension	Sub Research Question	Sample Questions from Survey
RQ.1	Recall	Are students able to recall participating in our activities?	Hire Thy Gator (HTG) Technical Interview Exercises consist of an activity where you get paired with a student and participate in mock interviews. Each student in the pair interviews the other student taking turns. Do you remember participating in mock interviews in any course in the UF curriculum? Options: (1) Yes, I participated in HTG activities. The course in which I participated in HTG activities was ___. (2) No, I did not participate in HTG activities. (3) Unsure, I do not remember if I participated in HTG activities. (4) Others, please specify ___
RQ.2	Efficacy of the activity	What are student opinions on the effectiveness of our activities on metrics such as usefulness, increasing familiarity with interviews, providing an environment for self-evaluation, or helping them build confidence, n-semesters after their participation?	HTG exercises (mock interviews): ▪ increased my familiarity with the technical interview process.* ▪ allowed me to understand my weaknesses and strengths to succeed in a future technical interview.* ▪ increased my self-confidence to succeed in a technical interview in the future.* ▪ are a useful activity that is beneficial for me to succeed in a future technical interview.*
RQ.3	Efficacy regarding subsequent preparation practices and applying behavior	Did our activities motivate and prepare students for subsequent interview preparation after our course as well as foster their agency to apply for internships/jobs?	HTG exercises (mock interviews) [prepared | motivated] me to - ▪ participate in subsequent mock interviews.* ▪ participate in subsequent individual programming practices (e.g., Leetcode style questions).* ▪ apply for internships or jobs related to computing.*
RQ.4	Efficacy for securing a job	What role did our activities play in helping students secure an internship or job post their participation?	▪ Mock interview exercises helped me in securing an internship/full-time job.* ▪ What role did HTG mock interview exercises play in helping you to secure an internship or a full-time job?#

* 5-point Likert Scale: Strongly agree to Strongly disagree; # Open-ended Qualitative Question

63% of students in our sample participated in at least one internship (37% in one internship, 18% in two internships, 5% in three internships, and 2% in more than three internships) and 37% of students did not pursue an internship. Of the latter 37% of the students, one-third never applied for an internship position, while the remaining two-third applied but failed to secure an internship.

6.2.5 Participants and Recruitment

Participants were recruited from courses that require our DSA course as a prerequisite such as software engineering, operating systems, introduction to machine learning, databases, and senior design. Our study was approved as exempt by Institutional Review Board at our university. Announcement emails on the course learning management system, Canvas, were sent by respective instructors to make students aware of the study. The students enrolled in these courses received 1% extra credit towards their final grade for their participation in our survey. They were also provided with an alternative assignment requiring equal effort in case they did not wish to participate in the study.

6.2.6 Data Collection

Our survey obtained consent from the students and consisted of seven sections: survey instructions, demographics, confidence levels, internship participation, preparation practices, intervention evaluation, and subsequent clarification. Students were asked to complete at most 49 questions based on their responses to questions which had skip or display logic. In this chapter, we use selected questions (see Table 6-2) from our survey from the demographics and intervention evaluation sections which are relevant for answering our research questions (see Table 6-1). These questions gauge whether students are able to recall our activity (RQ.1) and compare aggregate data of the perception of efficacy n-semesters after the activity with the data collected right after the activity in our previous study (RQ.2). Similar trends from the latter analysis across the two surveys will reinforce the benefits of our activities and provide empirical evidence regarding the effectiveness of our activities over the long term. Additionally, the questions investigate the perception of efficacy of our activities for motivating and preparing students to apply for internships/jobs and participating in subsequent interview preparation (RQ.3) and assess its impact on students' ability to secure an internship or job (RQ.4). Our survey was rolled out in fall 2024 and students spent on average 18 minutes to complete it.

6.2.7 Data Analysis

We use descriptive statistics such as mean and percentages to examine student responses to Likert scale statements for quantitative data. We analyzed one open-ended question (see Table 6-1) using inductive thematic analysis [21]. I coded the qualitative data into primary codes, which were further abstracted into themes. To verify the reliability of the coding scheme, my advisor reviewed the codebook to discuss the themes. In case of disagreements, the theme terminology was clarified, and the definitions were modified until a consensus was reached through an iterative process. This was followed by a frequency analysis on these codes and themes.

6.2.8 Authors' Positionality

I have worked as an intern and a full-time role in the software industry for multiple years and my advisor participated in four internships during her CS degree program. We both believe that participating in internships has value in gaining employment, and to secure employment, one has to take active steps outside of coursework such as participating in mock interviews or practicing technical interview questions. This position might have influenced our qualitative coding process.

6.3 Findings and Results

6.3.1 Recall (RQ.1)

Of the 508 students who completed the survey and this question, 74% of students (n=375) recalled participating in our activities. Of these 375 students, 92% (n=346) were able to correctly recall participating in them in our DSA course. 19% of the 508 students (n=94) claimed to have not participated in our activities and 8% (n=39) were unsure and did not remember participating. There was *not* a lot of variances across students from different cohorts (fall 2020 - summer 2024) who could recall participation as 70-78% recalled participating in our activities for all cohorts that had at least 10 respondents from a semester.

6.3.2 Efficacy of Our Activities (RQ.2)

A majority of students reported that our activities improved their familiarity with the technical interview process (*familiarity*, 92% strongly agreed or agreed), allowed them to understand their weaknesses and strengths (*self-evaluation*, 81% strongly agreed or agreed), increased their self-confidence to succeed in a technical interview in the future (*confidence*, 61% strongly agreed or agreed), and are a useful activity that is beneficial for them to succeed in a future technical interview (*usefulness*, 87% strongly agreed or agreed) one to twelve semesters after their participation in our activities. Note that for this analysis, we used data from 375 students who recall participating in our activities and completed all relevant survey questions (N=363). Further descriptive statistics regarding the student perception of the efficacy of our activities are shown in Table 6-2.

Table 6-2. Survey responses on the efficacy of Hire Thy Gator technical interview exercises (N=363) by students who recalled participating in our activities

RQ	Metric	Survey Option				
	Hire Thy Gator Technical interview activities:	strongly agree	somewhat agree	neither agree nor disagree	somewhat disagree	strongly disagree
RQ.2	increased my familiarity with the technical interview	45%	47%	4%	2%	1%
	allowed me to understand my weaknesses and strengths	40%	41%	10%	6%	3%
	increased my self-confidence to succeed in a technical interview	23%	38%	23%	11%	5%
	are a useful activity that is beneficial for me to succeed in an interview	45%	42%	9%	3%	1%
RQ.3	prepared me to - participate in subsequent mock interviews	26%	38%	28%	5%	3%
	prepared me to - participate in subsequent individual programming	33%	46%	16%	3%	2%
	prepared me to - apply for actual internships or jobs related to computing	26%	38%	26%	6%	3%
	motivated me to - participate in subsequent mock interviews	21%	33%	29%	13%	5%
	motivated me to - participate in subsequent individual programming	38%	40%	13%	7%	2%
	motivated me to - apply for actual internships or jobs related to computing	30%	34%	23%	9%	4%
RQ.4	helped me in securing an internship/full-time job	6%	27%	49%	9%	9%

We also computed the aggregate efficacy for these metrics by quantifying the 5-point Likert scale (coding “strongly agree” to 4 and “strongly disagree” to 0) and compared this data to our previous study which recorded similar metrics from 256 students who participated in our activities and provided this data right after their participation in fall 2020 (see Section 5.7.2 and Table 5-5, comparing score averages of students’ participation as an interviewer and as an interviewee for Round 1 of interviews). Right after their participation, students reported that our activities improved their *familiarity*, with an average score of μ_{f_i} = 3.46 on a scale of 0 to 4. In contrast, the students reported a slightly lower average score of μ_{f_n} = 3.33 on improving *familiarity* n-semesters after their participation in our activities. Similarly, with regard to *self-evaluation*, students right after the intervention reported an average score of μ_{s_i} = 3.34 and students n-semesters after their participation reported a mean score of μ_{s_n} = 3.09. For increasing *confidence*, the average score reported by students immediately after the activity was μ_{c_i} = 3.09 compared to μ_{c_d} = 2.63 from students who reported it n-semesters after their participation. Lastly, regarding the activities' *usefulness*, the average Likert score reported by students immediately after the activity was μ_{u_i} = 3.42 while the average score reported by students n-semesters after their participation was μ_{u_n} = 3.25.

Although these average scores decreased by 0.13 to 0.46 from the time when data were recorded after the intervention to the time when students were asked to recall, three of these metrics, familiarity (3.33), self-evaluation (3.09), and usefulness (3.25) were high on average, indicating that our activities are perceived as important based on the agreement (3: somewhat agree and 4: strongly agree). The last metric, confidence (2.63), showed the steepest decrease in the average score by 0.46 points. This could be attributed to the incidents and hardships that the students could have faced after participating in our activities and navigating the internship or full-time job application process. Previous work has documented such challenges that students face when trying to secure employment [12, 76, 101–103].

6.3.3 Efficacy Regarding Subsequent Preparation & Applying Behavior (RQ.3)

The majority of the 363 students who recalled our activities felt that our activities prepared or motivated them to participate in the subsequent interview practice and apply for internships and jobs (see Table 6-2). Regarding *preparation*, 64% of the 363 students agreed (strongly agreed or somewhat agreed) that our activities prepared them for subsequent mock interviews, 79% of students agreed that our activities prepared them for subsequent individual technical programming practice, and 64% students agreed that our activities prepared them to apply for internships and jobs. Regarding *motivation*, 54% of students agreed that our activities motivated them for subsequent mock interviews, 78% of students agreed that our activities motivated them for subsequent individual programming practice, and 64% of students felt motivated to apply for internships and jobs.

In addition, 82% of the 363 students also reported that they practiced solving technical interview questions (e.g., Leetcode style) on their own after the activities, 18% students practiced mock interviews with a friend, peer, etc., and 19% of the students practiced solving technical interview questions collaboratively. 16% of the 363 students did not participate in any subsequent preparation activities after our intervention.

6.3.4 Efficacy for Securing a Job (RQ.4)

6.3.4.1 Quantitative Results

We received mixed responses regarding students' perception of the efficacy of our activities in helping them secure an internship or a full-time job (see Table 6-2). Of the 363 students who recalled participating in our activities, 49% of the students (n=179), neither agreed nor disagreed that our activities helped them secure employment. Only 6% of the 363 students strongly agreed (n=22) and 27% of students agreed (n=99) that our activities helped them secure internships or full-time jobs. 9% of students somewhat disagreed (n=32) and 9% of students strongly disagreed (n=31) that our activities did not help them secure an internship or job.

6.3.4.2 Qualitative Findings

We received responses from 363 students who remembered participating in our activities regarding "*What role did mock interviews play in helping you to secure an internship or a full-time job?*". Of these, 16 responses were discarded due to responses such as "N/A" or off-topic responses. The remaining responses (N=347) were coded into 456 total codes or 29 unique codes. These 29 codes were further abstracted into three themes. Note that we perform frequency analysis by counting distinct students in each code/theme and some student responses fell into more than one theme and hence the aggregate counts may not add to 100%.

Derived value (71%). Student responses in this theme (310 codes from 248 of the 347 students, 71%) described that our activities were useful in preparing them for recruitment process of employment; however, they did not directly attribute that our activities helped them get a job or stated that they have not yet secured an internship or job. Prominent codes in this theme include promoting awareness of the process (n=155 students), practicing technical interviews (n=42), building self-confidence (n=33), fostering self-evaluation (n=21), preparing for interviews (n=19), encouraging subsequent preparation (n=17), and gaining new skills (n=10). Three students also described that, although they had a poor experience with an interviewer during the activity, they found the activity valuable.

Regarding awareness, students described that they felt more informed on the format of the interview, what to expect in a technical interview and from the interviewer, how to explain their thought process, and what they need to do to excel in the interviews (such as thinking before answering a question, asking follow-up questions from an interviewer, practicing more problems on Leetcode, etc.). For example, S396, a student who participated in our activities in fall 2023, stated that

> I have not technically secured an internship as of today, but the HTG activities provided strong hands-on experience of the process. It certainly made me gain a substantial amount of confidence for my future technical interviews.

Similarly, S444 stated that our activities "*prepared [them] with what to expect in a real interview. They helped [them] gauge when to ask questions, [...] and when to clarify or ask for clarification*". S182, a student who participated in our activities in fall 2022, stated that

> At the time I hated it, but looking back it was essential as that was my first introduction into how interviews for computing jobs work and what is expected in a technical interview.

The students reported that our activities helped build their confidence and motivated them to prepare subsequently to secure employment. For instance, students reported,

> The mock interviews gave me a bit more confidence in my programming abilities and made me motivated to do extra practice (leetcode, codechef, hackerrank, etc.) – S108

> Made it far more clear the standard of technical interviews, they feel easy to shrug off until you actually perform one, and in doing so it makes you realize many areas of critique. And so for me it not only helped motivate me to work on my lacking areas, but also made it far more urgent of a matter and something I prioritized further. – S404

> HTG exercises did not explicitly help me secure an internship however they did help me learn how to prepare for a technical interview by practicing using Leetcode problems. – S498

The students also described that our activities helped them practice or prepare for technical interviews or improve their technical or professional skills required for excelling in interviews. S410 stated that our activities

> Help[ed] me prepare a lot about soft skills such as coherence as well as technical skills such as preparing for a technical interview and how to properly express myself while coding by providing a safe place to practice and gain feedback from my peers.

Some students (n=21) also mentioned that our activities encouraged them to reflect on their strengths and weaknesses related to interview preparation. For instance, S174 stated that "*the coding aspect helped [them] realize which areas of CS [they are] not familiar with, and therefore, which types of problems they should practice*". S343 reported that "*It helped [them] to identify flaws and strengths in [their] interview process*" and S27 noted that

> The exercise helped open my eyes to how much I need to prepare. It's one thing doing problem on your own and another thing doing them in an interview setting.

Limited, unclear, or no role (39%). Student responses in this theme (139 codes from 134 of the 347 students, 39%) described that our activities played a limited role or had no role in them securing an internship/job. Some students attributed this limited role to not having applied for internships (n=8), not being invited to any technical interview (n=2), having a poor experience in our activity due to an unprepared interviewer (n=5), not securing an internship (n=5), or because of them applying to jobs in non-technical fields or computing roles which did not require coding interviews but rather behavioral questions (n=13). For instance, S170 stated that the role of our activities in them securing employment is "*none so far, as [they] have not acquired an internship or full-time job*". S284 described the role as

> None, as I am going to work in the Networking/Cybersecurity Engineering field and my past interviews did not include coding as they were not strictly programming roles where I interviewed.

Similarly, S517 stated that they "*have not used [our activities], since [they] have not had to interview for any software-related jobs (only EE jobs)*". S341 commented that our activities "*have not yet helped [them]. [They] have applied to many positions (around 200+) but have not yet gotten an interview*."

Other students made general comments without attributing the limited role to our activities but explaining that they did not apply for a job (n=3) or did not secure an interview (n=12) or internship (n=34). The latter students often described our activities as useful (similar to the last theme) and indicated that our activities have yet to play a role in them securing employment. S454 stated that *"[they] have not completed a real technical interview yet*" and S447 reported that they "*have not secured an internship yet, but [they] remember the mock interview gave [them] a little bit more confidence about [their] thought process*". S283 described that *"[they] have not applied yet but [the activities] gave [them] a little bit of experience*".

Five students were uncertain about the role of our activities in securing employment. For instance, S355 noted that they "*have yet to participate in a technical interview for this hiring season, so [they are unsure*". Two students stated that they already had a job and prior experience, and hence did not know about the role of our activities, and two students reported that much more practice on technical problems is necessary to secure a job. A student response belonging to the latter, S146, stated that

> It didn't [response to the role of our activities in securing employment] but that's because I think much more preparation is needed in addition to mock interviews, which I did AFTER the DSA one and then in Enterprise SWE I did the interview after preparing on my own and securing an internship.

Positive outcome (2%). Seven of the 347 students (2%) reported that our activities helped them clear technical interviews (n=2) or secure an internship (n=5) in companies such as Microsoft, Verizon, etc. For instance, students described that our HTG activites:

> Helped me practice talking out loud while solving coding problem. Get to know my strengths and areas that needed improvement before a technical interview. Helped me secure a software engineering internship with JPMorganChase - S166

> HTG helped me prepare for career fair and the Grace Hopper conference in which I had to interview with recruiters, and ultimately ended up receiving an internship offer. – S23

> Gave me a feel for how it was during the real thing, it was quite accurate. I was able to ace my first ever technicals and get an internship at Microsoft – S259

> HTG helped me prepared for my interviews and I was able to get a summer 2025 Internship.- S335

6.4 Discussion and Conclusion

In conclusion, we present a retrospective evaluation of our technical interview activities, adding empirical results on students' perception of the efficacy of our activities to the computing education research literature. These results provide valuable insights into the role of our activities in supporting students' readiness for computing internships and jobs. Although our activities were perceived as beneficial and a third of the students agreed that they helped them secure an internship or job, a majority of the students reported that our activities alone limit their ability to secure an internship or full-time job, and additional preparation is needed to secure employment. This suggests that while our activities are effective as preparatory tools, they must be supplemented by broader exposure to more extensive practice resources. Nevertheless, our activities increased student self-confidence, improved their familiarity with the process, provided opportunities for self-assessment, and motivated and prepared students to subsequently prepare for employment opportunities, thus promoting the development of metacognitive [98] and professional skills [53] in students. Since our activities require minimal changes in course workflows, we recommend other instructors introduce these activities, especially in DSA courses, given the overlap with the course content.

Additionally, our work also provides baseline data for researchers or practitioners who develop similar activities or courses to prepare students for technical interviews in the future. This data is self-reported and may introduce biases, such as over- or underestimating the activities' impact. In the future, more careful experiments can be designed to assess the causal efficacy of our activities.

6.5 Limitations

Our survey response rate is low, as finding students who have participated in our activities is difficult, which is typical of longitudinal panel studies [42]. However, we purposefully recruited students from upper-level courses offered in our department who would have experience with applying for internships and jobs.

Additionally, there might be some students who would have graduated before fall 2024 when we collected data or students would have dropped out from the program or the computing discipline since our intervention’s first offering in fall 2020. The latter may induce *survivorship bias* [97] in our sample as we do not cover the voices of students who may have dropped out from computing.

Another limitation of our study is the *single group threat* [158] as we do not collect data from a control group of students who did not participate in our activities and are in final years of their computing programs. Researchers in the future can identify how and when students become aware of the technical interview process and start the preparation process if they did not get a chance to participate in similar activities that we introduced.

Students in our sample are also subject to *maturation effects* [151] as they would have prepared for technical interviews after my course. They may fail to recall our activities or conflate it with subsequent preparation activities that they participated in outside of the curriculum or in another course. We have added additional checks to our open-ended questions to ensure that students are answering responses that relate to their participation in our activities. We explicitly ask them to explain the impact of our activities on subsequent interview preparation and for securing a job to better understand the impact of our activities. Additionally, we used data for analysis from students who recalled participating in our activities.

Lastly, we will attempt to address the *validity* of our qualitative inquiry through the transparency of our research process, using participants' quotes, as well as revealing the researchers' positionality [42].

CHAPTER 7
CONTRIBUTIONS AND CONCLUSIONS

My dissertation's contributions to the Computing Education Research (CER) community and computing practitioners include empirical [76, 77, 81, 84, 165], theoretical, and pedagogical [87, 88] contributions.

7.1 Empirical Contribution

My initial work on identity formation in computing has evaluated how researchers conceptualize and operationalize identity in computing education [86], identified how computing students conceptualize their professional identities [78, 79], the factors and avenues that influence identity formation processes [83], and the chronology of this process [83] in the context of computing undergraduate degree programs. This research provided insight into the crucial role played by informal and non-formal learning environments such as internships, personal projects, student organizations, and hackathons on students' identity formation. Subsequently, I started focusing on the underexplored area of internships in computing while most other research focused on formal education in the context of academic programs [15, 44, 129, 130, 147]. For computing internships, I assessed the impact of internships on undergraduate computing students [81], identified who participates [77, 84, 165] and who does not [76, 77, 165], and explored the preparation processes of students for securing internships [84]. I add to the CER literature the following empirical results:

1. Rich descriptions of
    a) the value computing undergraduate students receive from participating in internships [81].
    b) students' preparation processes for securing internships [84] and the strategies they use for securing internships.

2. Baseline data on

    a) attributes of students' who participate in internships [84, 165].

    b) students' confidence levels to secure internships before and after a course that has an overlap with technical interviews [88].

3. A qualitative categorization model describing students' barriers to participation in internships [76].

4. A statistical model for identifying undergraduate computing students who will likely and not likely participate in internships based on demographics, socio-economic factors, academic factors, external involvement factors, and identity formation [165].

7.2 Theoretical Contribution

My dissertation also contributes to the CER literature, rich student personas describing their participation in internships. The phenomenon of interest for these personas was to understand the differences between students who successfully participate in internships before graduation and those who are unsuccessful in securing internships. These personas emphasize:

1. strategies and challenges students face when going through the internship recruitment process.

2. salient attributes of students who successfully secure internships and those who are unsuccessful in securing internships.

3. elucidate stakeholders in formal, non-formal, and informal education that are involved in students' participation and preparation process for securing internships.

7.3 Pedagogical Contribution

Since a substantial number of students fail to participate in internships due to psychosocial and financial constraints [76], I have created and incorporated a pedagogical intervention, *Hire Thy Gator Technical Interview Exercises,* in a large computing core course [85, 88] so that all students can become aware as well as feel prepared for the internship recruitment process. My dissertation also contributes both rich pedagogical descriptions as well as an empirical analysis of the efficacy of this intervention. Practitioners and educators can use the open-source resources [87] and learn from the best practices of incorporating our pedagogical activity in instruction. In addition, I have released baseline data on students' awareness and confidence on succeeding in technical interviews *before and after* the intervention from a sample of undergraduate computing students at a large public university in the USA [88] and *a retrospective evaluation* one to twelve semesters after student participation in our activities. This data can be used to tailor the intervention or propose new interventions across other types of institutions depending on student profiles.

7.4 Conclusions

My dissertation explored fundamental research on computing students' participation in internships through the lens of James Marcia's theory of identity development [104], Bandura's Social Cognitive Theory [6] and Lent et al.'s Social Cognitive Career Theory [25, 93]. My work provides a comprehensive understanding of the importance of internships and the factors influencing computing students' participation, highlighting student attributes, strategies, and challenges. We developed student personas embodying both successful interns and those who did not participate in internships. Our findings indicate that students who secured internships demonstrated higher levels of agency, intentionality, ambition, and self-regulation. They proactively employed various strategies, such as early and frequent applications, explicit interview preparation, participation in technical conferences, and networking.

In contrast, students who did not intern were more likely to rely solely on coursework, exhibited lower self-efficacy, lacked a structured career preparation approach, and faced barriers such as competing priorities, financial burdens, identity diffusion (low exploration and low commitment), and a lack of awareness of the hiring process or career options. These disparities underscore the need for targeted interventions that provide both motivation and resources to help students navigate the job recruitment process effectively. These interventions should specially be designed to support at-risk students, including transfer students, students who have switched majors, students from low socioeconomic backgrounds, those with family responsibilities, and non-traditional students.

To address some of these challenges, we also developed and evaluated Hire Thy Gator Technical Interview Exercises, an intervention designed to support students in technical interview preparation. Participants found our mock interview exercises helpful, reporting increased awareness of the recruitment process, and suggested that the activities improved their confidence in succeeding in future technical interviews as well as prepared and motivated them for subsequent interview preparation. However, they noted that the activities alone were insufficient for securing an internship, emphasizing the need for continued, explicit technical interview practice post our intervention.

Our observations highlight the critical role of both individual agency and support from social structures in facilitating computing students' participation in internships. The findings also support our theory of change based on Bandura’s Social Cognitive Theory [6] (shown in Figure 2-1). I failed to find a single student in my interview data corpus who could not secure an internship but (1) had a goal to secure an internship, (2) was actively involved in activities outside the curriculum to build skills sought by employers, (3) was proactively preparing for interviews, and (4) was actually applying for internships. This highlights that a student’s agency plays a key role in securing an internship. Additionally, most of the personas of successful interns and those who were unsuccessful in participating in internships fell in the moratorium (high exploration, low commitment) or achieved (high exploration, high commitment) identity statuses confirming our results from our quantitative model, that identity statuses except diffusion (low exploration and low commitment), failed to predict internship participation in computing.

Future research should explore how students transition between personas throughout their academics via longitudinal studies, shedding light on their career trajectories. Additionally, predictive models can be built and examined to identify students at risk of missing out on internships or the personas we developed to help institutions make timely tailored interventions. Finally, given the evolving hiring landscape, future research should examine how labor market shifts, particularly post Covid-19, impact students' internship participation and assess the validity of the developed personas across labor market shifts and different geographic and economic contexts.

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BIOGRAPHICAL SKETCH

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