Attitude shifts and transformation during Computer Science and Engineering Student Internships

Dr. Mia Minnes, University of California, San Diego

I am an Associate Teaching Professor in the Computer Science and Engineering Department at UC San Diego. My research interests lie in theory of computation (specifically resource-bounded computability theory and algorithmic randomness) and CS education and professional development (designing and studying community- and cohort-building initiatives, researching and enhancing the academic-industry transition for entering professionals).

Dr. Sheena Ghanbari Serslev, University of California San Diego

Dr. Sheena Ghanbari Serslev’s research interests include creativity and learning, program assessment, and faculty development. She strives to create engaging and accessible environments that promote teaching and learning.

Madison Edwards
Attitude shifts and transformation during Computer Science and Engineering Student Internships

Mia Minnes Computer Science and Engineering
University of California, San Diego
minnes@eng.ucsd.edu

Sheena Ghanbari Serslev Teaching and Learning Commons
University of California, San Diego
sserslev@ucsd.edu

Madison Edwards Chemistry and Biochemistry
University of California, San Diego
m4edward@ucsd.edu

Abstract

This study explores how industry internships, paired with scaffolded reflection, shape student attitudes and learning behaviors. Building upon the literature on student motivation, we seek to answer the following question: how do internships influence student attitudes towards their studies and their future approaches towards learning? Data at three critical points in a student internship (before, right after, and several months later) are used to measure the evolution of student perspectives on academics and the Tech industry. This paper uses a mixed-methods approach, where open-ended student reflections on their internship are coded and unpacked, and then compared to a statistical analysis of student responses to a survey including the Motivated Strategies for Learning Questionnaire (MSLQ) before and after the internship experience. Students expressed overwhelmingly positive academic and industry dispositional changes. They expressed increased appreciation for the opportunities they have had and increased awareness of the importance of interpersonal relationships and lifelong learning. Students spoke to specific actions and behaviors they plan to take after the internship experience, reflecting their heightened maturity and sense of direction. Additionally, the internship illuminated the importance of building interpersonal skills, exhibiting personal growth, and developing attributes of lifelong learning. In contrast to these conclusions, pre- and post-survey analysis for the MSLQ with the same group of students reveals specific areas where student motivation decreased after the internship experience. These findings point to the important formative role internships can play in an undergraduate Computer Science and Engineering program and shed light on the lessons universities can learn about leveraging student enthusiasm at the end of their internship to enhance the ensuing continuation of their academic experience.

A. Introduction

Demand for undergraduate Computer Science and Engineering (CSE) education continues to grow, driven by persistent need for professionals with technical skills. In addition to core technical knowledge, students embarking on a career in CSE must be ready to combine theory and practice in a context where the underlying technology continually changes, projects are large-scale and collaborative, and professional responsibility and ethics-based decision-making are critical when products are adopted widely. Many students seek hands-on industry internship experiences to complement their in-class instruction and prepare for these careers.

To better frame and assess CSE internship experiences, we analyze motivational changes in CSE students who participated in full-time, on-site, paid internships. Internships lasted eight to fourteen weeks and were paired with a companion course that aims to facilitate connections between students’ work-based and academic learning. Throughout this course, students investigated themes of technical skills, personal and professional growth, and ethics and society. We analyze the changes in students’ academic self-regulation and disposition after their internship experiences using a pre-and-post survey design complemented with
qualitative analysis of student responses to the following question: “In what ways will your attitude toward your studies at [school anonymized for publication] change as a result of your internship? How will your experiences this summer shape your approach to next quarter and beyond?” at the end of their internship. This mixed-methods approach helps us track students’ motivations, perspectives, and plans for action and situates their internship as an integral part of their CSE undergraduate education.

B. Background

1) The role of motivation in learning: Motivation is critical to learning and leads one to pursue and continue to pursue an objective [1, Part II]. Importantly, motivation is believed to be an emergent phenomenon, meaning it can develop over time and be updated based on new experiences. As described in [2], self-efficacy theory [3] and situational interest theory [4] both support the observation that motivation may be “fluid and situationally dependent”. Students are motivated when they perceive a task has value to them, when they expect to successfully accomplish the task, and when they are able to work on the task in a supportive environment [5, Chapter 3]. When students are motivated, they follow goal-directed behavior that supports their learning and success. Students may be motivated by performance-based or learning-based goals: students motivated by learning goals pursue tasks in order to gain skills or learn from an activity, whereas performance-based goals serve to protect one’s reputation. Most research suggests that students motivated by learning goals are more likely to seek help when needed, develop study strategies for deeper understanding, and take on and persist through challenging tasks [5, Chapter 3].

Internships provide students with real-world tasks, demonstrate the relevance of students’ course work to their future careers, and create opportunities for students to see the value of their efforts. In previous work, studies indicate students value internships for the opportunity to develop technical skills, expand professional networks, and complete a product that others will find useful [6]. When students perceive that an activity will help them satisfy more than one goal, their motivation will be higher [5, Chapter 3]. Furthermore, students who expect to succeed and believe they have influence within their learning environment will be more likely to pursue challenges and overcome obstacles [1, Part II]. Since internships may help students develop the expectation that they can succeed in industry after graduation, it is reasonable to expect that they may boost students’ motivation to succeed in their courses and to seek help from others to facilitate this success.

Research on motivation has relied to a great extent on self-reported measures of motivation, as it is often assumed that individuals are aware of their source of motivation [2]. In self-reported measures of motivation, participants generally use a Likert-scale format to respond to questions on self-descriptive statements of attitude or behavior. Self-report measures often focus on multiple aspects of motivation, for example, the Patterns of Adaptive Learning Scales [7] focuses both on cognitive and social aspects of motivation, while the Motivated Strategies for Learning Questionnaire [8] covers affect, value judgements, expectancy beliefs and intrinsic/extrinsic sources of motivation. Dörnyei notes that in extended learning processes, students’ motivation must persist through continual reassessments of interest triggered by various internal and external influences [9]. Elliot observed that qualitative approaches (such as an interview) may be combined with a quantitative self-report measure to provide a clearer picture of an individual’s motivation; in particular, it has been observed that interview responses are often inconsistent with self-reported data [10].

For these reasons, we have chosen to quantitatively analyze changes in students’ academic self-regulation after completing an internship, using an adapted version of Pintrich and DeGroot’s Motivated Strategies for Learning Questionnaire (MSLQ) [8], provided by Stelar [11]. The MSLQ was created within a social-cognitive theoretical framework that posits that motivation and learning are dynamic, based on their context, and that students can learn and choose the learning strategies they use [12]. The MSLQ
is a reliable tool that has been adapted for many purposes, including studying the relationship between self-regulated learning strategies and academic success [13], the relation between college students’ help seeking and their views of their courses’ achievement goal structure [14], and the relations between metacognition, strategy use and motivation [15]. In this project, we use the MSLQ as one indicator of differences in students’ motivations prior and following a summer internship experience. To gain insight into students’ motivation we pair the adapted MSLQ with qualitative analysis of a summative reflection by students upon completion of their internships.

2) Study skills exhibited by self-regulated learners: As students develop into independent learners, goal-directed practice with timely, targeted feedback is critical to learning [5, Chapter 5]. As they advance in their field of study, successful students may develop the ability to determine where their performance lies relative to their desired performance level. At this point, students are self-regulated learners: they can set their own learning goals, determine how to best accomplish these goals, and monitor their progress in accomplishing them [1, Part II].

When self-regulated learners perceive deficits in their learning, they exhibit adaptive help-seeking: asking others for the resources necessary in order to learn independently [16], [17]. Students may engage in formal (approaching an instructor) or informal (approaching a peer or friend) help-seeking behavior. Students who use more metacognitive, cognitive, and resource management strategies are more likely to seek help when needed. Furthermore, students who exhibit high self-esteem appear more likely to seek help when needed, whereas students with lower self-esteem perceive help-seeking as threatening. Thus, students who seek help are reflective about their learning, aware of the resources available to them, and confident enough to take advantage of those resources [17]. This project collects data on students’ help-seeking behavior before and after an internship experience, as evidence of their potential increased confidence and ownership of their learning.

3) The role of university experiences in helping students along the process of professionalization: As universities strive to prepare their CSE graduates for careers in industry, two fundamental questions are (1) what aspects of industry do CSE students have trouble adapting to, and (2) what skills might CSE students lack that would prevent them from being hired? Radermacher et al. [18] documented hurdles facing recent graduates. They write that the greatest challenges for recent graduates involve effectively communicating with customers and coworkers, using software tools and configuration management systems, and creating unit tests for code. Also, the most common issues preventing students from obtaining a position at a company were a lack of problem-solving abilities and project experience. Eric Brechner, Director of Microsoft Development Training, voices similar concerns about the inadequate preparation of CSE college graduates transitioning to full-time positions and cites the following as areas of needed preparation: software design and analysis; writing code that will be integrated into a larger project; lasting, quality code for diverse users; and the ability to work on a multidisciplinary team [19].

Given these high standards for preparation to enter the professional CSE industry, courses alone may not be sufficient. Lawrence-Fowler et al. [20] argue that, in addition to preparing students with the knowledge and technical skills required in industry, it is equally important to produce graduates who can adapt and navigate the evolving field of CSE. To prepare students to be nimble and successful jumping into new roles throughout their career, universities need not only impart discipline-specific skills, but also foster the development of social and personal competence skills. Authentic experiences in which they practice solving real-world problems, using industry-grade tools, and communicating with coworkers and customers may be an effective way to develop these skills.

4) Prevalence of CSE Internships: Universities implement a variety of approaches to address this need: some are incorporating real-world projects into their courses [21], creating on-campus centers where
students work on projects for real clients [22], encouraging student participation in internship programs [23], or even creating programs that combine undergraduate research with industry internships [24]. All these experiences provide students with additional preparation for careers in CSE beyond what is offered in academic courses. Such experiential learning experiences are grounded in John Dewey’s theory of Learning by Doing and are defined by learning a concept through experiencing it or working directly with said concept [25]. Several projects evaluate the extent to which each experience prepares students. At Ohio State University [21], students who participated in an internship, a real-world project, or capstone classes were surveyed on their perceived improvement in various technical and non-technical categories such as integrating multiple technologies, analyzing cost/benefit tradeoffs, leadership skills, teamwork, communication, and personal growth. This survey indicated that compared to capstone classes and real-world projects, internships resulted in the greatest improvement in all categories except for independent learning (in which the real-world project provided an equal level of improvement) and teamwork. Chillas et al. [26] document the differences in accessibility of each of these experiential learning programs to students: students who demonstrate “soft” skills appear more likely to gain internships, which may have the strongest positive outcomes. The wide range of experiential learning programs implemented in universities may serve as a remedy, allowing students a chance to develop the skills necessary to be hired for an internship by first completing a local experience with lower barriers to participation. In this work we focus on industry internship programs in which students learn and develop the skills needed for an industry position in CSE through working on real-world problems in an authentic context and environment.

C. Program Structure and Project Methods

This project took place in a public research-intensive institution in the western United States with a large undergraduate CSE population (approximately 2000 majors, roughly 20% of whom are women). Students who have obtained a full-time, on-site, paid internship opportunity may choose to enroll in a companion course which counts for credit towards their degree. Students enroll in this course concurrently with their internship experience and participate in daily journaling, weekly reflective writing, and online group discussions about their experiences. Through these activities, students explore the growth and application of their technical skills, their personal and interpersonal development, and the ethical implications of our discipline and its role in society. This course is intended to deepen the internship experience and to provide a vehicle for professional growth by exploring important questions in an authentic context. In this project, we study how this combination of an immersive internship experience and its companion course shifts students’ perspectives on their studies and future careers.

In this paper, we consider the offering of the course in Summer 2018 (enrollment 108 students). These students were all undergraduate CSE majors. For the majority of these students (104 students), their summer internship was their first time working at the company hosting their internship. While students worked on-site at many different companies hosting internship programs, students formed a cohort for their class activities (which were conducted remotely, synchronously with the internship).

We now detail the methodology of our quantitative and qualitative approaches to collecting and analyzing data. The timeline of our data collection began with an initial pre-survey before the internship experience, followed by a summative reflection upon completion of the internship (roughly 8 to 15 weeks later), and finally, seven weeks after the internship experience, the post-survey was administered. Our intent with this sequence was to document student motivation and attitudes before the internship, immediately after the internship, and well after the experience.

1) Statistical analysis comparing pre-survey and post-survey responses: The instructor integrated an adaptation of the Motivated Strategies for Learning Questionnaire into both the pre-internship and post-internship surveys administered as part of the internship companion course. The coursework
was customized for two tracks of students (depending on individual course enrollment needs), which completed the second (post-internship) survey at different times. Only one track of students is included in the comparative survey analysis (those who took the post-survey later). Also, any partial data from students who did not complete both surveys were removed from our analysis. There were 60 paired student survey responses.

We conducted a paired two-tailed t-test on the pre- and post- survey results to check for significant changes in student motivation after their internship experience. These findings are examined in the Data and Results section. The complete internship pre-survey and post-survey is included in the Appendix.

The surveys also included questions on the resources used by students while studying in CSE classes. The responses to these questions were analyzed to compare any differences in the patterns of help-seeking behavior before and after student internships.

2) Grounded theory qualitative analysis: The quantitative analysis is paired with qualitative analysis of student responses. Immediately upon completion of their internship students responded to the following question: “In what ways will your attitude toward your studies at [school anonymized for publication] change as a result of your internship? How will your experiences this summer shape your approach to next quarter and beyond?”

There were 102 completed student responses and all of these were integrated in our qualitative analysis. Utilizing a grounded theory approach, themes emerged from the data set [27]. The responses were coded distinctively by two researchers and then reviewed by those researchers. Distinct units of thought were separated into quotations and coded. The researchers discussed initial findings and a coding schema emerged in which disposition shifts towards academics and industry were classified as positive, neutral, and negative. Additional categories emerged to document quotes about specific actions students wanted to take as a result of their internship process. Our inductive coding process captured these themes and used the language from student responses to guide the development of categories and codes. In addition to capturing attitude shifts we also noted the following broad thematic categories: Relationships and Communication, Lifelong Learning, and Personal Growth. Relationships and Communication encompassed student attitudes and behaviors regarding interpersonal skills; Lifelong Learning captured a student’s desire to continue to learn and find ways to align their interest with their careers; and the Personal Growth category included discussion of increased confidence, organizational skills, and maturity. The most frequently cited codes are included in the Data and Results section.

D. Data and Results

We collected data at three key milestones in the project: (1) before students began their summer internships (a survey measuring their current attitudes and behaviors at school); (2) at the conclusion of their summer internships (open-ended responses to the reflection prompt “In what ways will your attitude toward your studies at [school anonymized for publication] change as a result of your internship? How will your experiences this summer shape your approach to next quarter and beyond?”); and (3) approximately two months after their summer internships, when students were in the midst of their next term at school (the same survey as before, measuring their current attitudes and behaviors at school). In this section, we report on the qualitative analysis of the reflection prompt responses as well as a statistical analysis comparing the pre-internship and post-internship survey data.

The data are sorted into descriptions of two kinds of changes: attitude shifts and planned actions. We begin this section with an analysis of students’ motivations and dispositions: first we explore themes that emerge in the student open-ended responses and that describe shifts in perspectives, preferences, or
mindset. We complement this analysis by studying changes in students’ reported motivation and interest via a pre- and post-analysis of students’ MSLQ responses. The remaining two subsections of this Data and Results section focus on the actions students planned to take after their internship, as well as data on whether they followed through on these plans.

**Qualitative analysis of attitude shifts at the conclusion of summer internships**

1) *Academic disposition:* The vast majority of student responses to the reflection prompt at the end of their internship expressed an increased appreciation of their studies. A dominant theme was that students now saw more value in the specific courses they had taken at college. Students reported referring back to their course notes during their internships and appreciating the easy reference that they provided. Many students expressed a new way of thinking about their coursework: after seeing the practical applications of the course content during their internships, students were more appreciative of what they had learned (even in what they had considered boring or non-core classes when they were taking them). Some students elaborated on this theme and observed that classes that contributed to their general fluency in CSE ideas, even if they were not immediately applicable, were an important part of their education. For example:

> I definitely feel like in my last [school term], I will appreciate the quality of classes and the learning process a lot more. Seeing how the material I learned in my classes applied in industry has shifted my perspective on taking classes at [school]. I want to be more thorough in taking notes and documenting material I learn that I believe will be relevant for potential work in the future because I feel like there were occasions where it would have been useful to be able to reference notes from school. If I had been more methodical in my notetaking, my notes would have been much more reusable.

The internship experience helped many students make connections between class concepts they had learned and see their relevance. This “big picture” perspective helped increase their motivation for future classes. For example:

> I realize now that even if some courses may not be useful to me, it’s important to have a general understanding of everything. Instead of focusing on the small details of what we’re learning, I’ll look at the bigger picture and think about why we’re learning it. I’m actually more excited to come back to school not only because I’ll be taking exciting classes taught by amazing professors, but also because college is really a precious, short experience that I’ve taken for granted. This internship has helped me realize that everything we’ve gained from the coursework at [school] will help us do more meaningful work in the future.

In addition to this higher-level view of the value of an undergraduate degree in providing context for the discipline, students reported appreciating core problem-solving skills that they had honed in their undergraduate classes. Many responses distinguished between industry, where specific technologies and languages need to be mastered quickly to be applied, and school, where foundations are built and students “learn how to learn”. In general, students felt well-prepared for their internships and expressed gratitude for school for helping them get ready to learn new technologies and languages quickly and tackle problems with persistence and critical thinking.

> I have come to realize that no matter what [school] teaches me in regard to coding, it has foremost taught me to work hard and work consistently. I believe this is the biggest skill and a habit that I have developed through the constant assignments and approaching daily deadlines. At work whenever I was working with something that was new to me and I was having a hard
time I always had it at the back of my mind that I will eventually figure it out no matter how much time it takes. All the programming assignments gave me this mindset of persistence and that’s what I value the most.

More philosophically, students expressed an increased appreciation for the undergraduate time of life and the freedom it provides to explore their interests and their identity. Overwhelmingly, student responses describing shifts in perspectives on undergraduate studies were positive. Highlighted among these responses were the value of classes and instruction for learning foundational CSE concepts and the freedom to choose topics to explore afforded by the structure of college. After their internships, students were more aware of the interconnectedness of the topics they were studying at school and valued developing a broader and deeper understanding of their discipline.

2) **Industry Disposition:** Another common thread through many of the student reflections addressed their evolving perspectives on CSE industry positions. Many students reflected on the increased motivation and seriousness they brought to their work when the projects they worked on were customer-facing and when they were working as part of a team where others relied on them to be successful. Students’ internship experiences often affirmed their career choice, leaving them energized and motivated for their future steps.

For the first time ever, I feel like I actually belong in this field and that I can have a lasting impact on this industry, I think that, of all the things I discovered this summer, is what’s going to stay with me when I start my career . . .

Observing their colleagues and noticing the extent to which they had to learn new technologies on the job, students noted that life-long learning is an essential feature of CSE industry positions. For example:

From the internship, I had a grasp of the feeling of the ever-changing nature of the software industry. To keep up with your team, you have to learn at all times: at your workspace or at some of your free time, about the technologies your team is using or considers to use. In addition to that, you would also way to play around with emerging technologies that could be prevalent in five years. To succeed in your career, you want to be self-motivated and hungry for knowledge of different levels instead of being satisfied with taking in information only from the domain you specializes [sic] in...

With this fuller view of what a tech career entails, students also commented on the realities of full-time jobs and the value of a healthy pace and balance. Summer internships are immersive short-term forays into tech companies. Students left these experiences mostly energized to return, and with new insights on the value of life-long learning in the tech industry.

3) **Importance of relationships and personal growth:** The summer internship experience was formative for many students, facilitating personal growth. Students reported increased organizational skills, persistence, and maturity. Many students drew increased confidence from the intensity of their internship experience: they had persevered through challenges and had been successful. This served as inspiration and motivation for increased success in future classes and beyond. For example:

Since I was able to overcome a lot of difficult problems in device software while learning more about the concepts my project needed, I will be trying to take courses that do intimidate me, because I want to challenge myself more. If something seems hard, I have a lot more motivation to just do my best to overcome them instead of trying to back off.
Students also reported learning about their own strengths and weaknesses as a result of their internship. Students’ managers were instrumental in guiding these journeys of self-discovery. Students appreciated managers who mentored them both with work projects and general career coaching.

The theme of asking for help recurred frequently in student reflections. At the start of their internships, students typically had no knowledge of the existing codebase and often no prior experience with the technologies being used. As such, they were expected to reach out for help from team members and managers to get up to speed quickly. Many students reflected that this experience normalized needing help and that they came to value asking (good, timely, and relevant) questions.

This summer has made me more open with asking questions and curious to learn more. I have always been tentative asking questions because of being scared that I would seem stupid, but now I am less scared.

This openness to needing help led to an increased appreciation of communication in general. Students came to see how critical collaboration is in large-scale projects.

The internship experience occasionally led students to better understand what they didn’t like. Some students were so energized by working on projects which impacted others that they were reluctant to return to school. On the other hand, one student’s experience led them to re-evaluate their career choices. Summer internship experiences were often experiences of intense growth and self-learning for students. These internships helped shape students’ views on collaboration, help-seeking, and career goals.

**Quantitative analysis of pre- and post-survey MSLQ results**

The 44 questions in the motivation survey were analyzed for differences in the distribution of student responses before and after their summer internship program. The pre-survey was administered in the month before students started their internship program. Due to staggered starting dates of summer internships, the survey completion dates ranged from June 14, 2018 to July 18, 2018. The post-survey was administered near the end of the academic term immediately following the internship. Students were given a three-week window during which to complete the survey and completion dates ranged from November 19, 2018 to December 13, 2018. We report the results of a two-tailed t-test on the matched pre- and post-survey values for those questions which showed a significant (at the $< 0.1$ or $< 0.05$ confidence level) change.

In each row of Table I, we see that the average response to the question goes down, indicating less agreement with these statements. In all these questions, students’ motivations appears to go down in the post-survey compared to the pre-survey.

**Qualitative analysis of planned actions and behavioral changes**

We now turn back to the open-ended student responses written at the end of summer internships. We analyzed the themes that emerged from these responses in which students spoke of changing their behavior as a result of their internship. The majority of students’ plans centered around their behavior back at school; we’ll mention one theme that emerged concerning their future job search plans.

Many students spoke of how participating in their internships increased their awareness of specialized sub-disciplines within CSE. This new knowledge informed their elective course choices, with students mentioning interest in upper-division networking, artificial intelligence and machine learning, databases, web development, security, advanced math and statistics, and more. Some students also planned to take non-CSE classes to round out their education, for example in management, public speaking, or design.
Now that they had experienced applying their knowledge in industry, many students resolved to pay more attention in their future classes. Students noticed that learning independently, as many had to do on the job while at their internship, can be slow and inefficient. In light of this, students planned to extract as much as they could from their remaining classes.

There are so many times where I had to relearn how to do something I already learned in class and there were also a lot of times where I was so glad that I had taken the time to learn something well in class, otherwise I would have been useless at a task. So my internship has helped motivate me to be a better and more responsible student.

Elaborating on this, many students wrote of their plans to take more ownership of their own learning. For example, in classes that do not directly speak to applications, some students planned researching on their own to find connections with industry and developing side projects to demonstrate these connections. Students noticed that curiosity and taking initiative were valued in the workplace and planned to act according to these principles during their coursework as well.

I want to understand how the concepts that I’m learning in the courses are applied to the bigger picture and how it can be used in industry! That being said, studying will probably look different for me this year as I will probably be more focused on taking more time to understand the concepts and how they can be used in different software engineering skills and tasks rather than just attempting to memorize everything last minute for a class.

Many students came to realize that GPA isn’t as critical as they had previously believed. Diving in, we saw two separate threads in this theme: some students expressed that grades had been important for getting job offers in lieu of previous industry experience but that now they could relax because their “job experience opens doors”; other students still valued high grades but realized that focusing on understanding (rather than points) would be more useful in the long-term, and would also as a side-effect produce the desired grades. Either way, students expressed a sense of relief that they could restructure their studies to emphasize conceptual understanding rather than perfect scores:

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-survey mean</th>
<th>Pre-survey standard dev.</th>
<th>Post-survey mean</th>
<th>Post-survey standard dev.</th>
<th>Significance (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like what I am learning in my classes*</td>
<td>5.73</td>
<td>0.92</td>
<td>5.40</td>
<td>0.99</td>
<td>0.0318</td>
</tr>
<tr>
<td>I’m certain I can understand the ideas taught in the courses I am taking</td>
<td>5.53</td>
<td>1.19</td>
<td>5.22</td>
<td>1.19</td>
<td>0.0606</td>
</tr>
<tr>
<td>I think I will be able to use what I learn in my classes in other classes</td>
<td>5.52</td>
<td>1.07</td>
<td>5.17</td>
<td>1.26</td>
<td>0.0703</td>
</tr>
<tr>
<td>I think that what I am learning in my classes is useful for me to know*</td>
<td>5.67</td>
<td>0.97</td>
<td>5.22</td>
<td>1.21</td>
<td>0.0062</td>
</tr>
<tr>
<td>My study skills are excellent compared with others in my classes</td>
<td>4.28</td>
<td>1.54</td>
<td>4.02</td>
<td>1.60</td>
<td>0.059</td>
</tr>
<tr>
<td>I think that what we are learning in my classes is interesting*</td>
<td>5.70</td>
<td>0.93</td>
<td>5.30</td>
<td>1.00</td>
<td>0.003</td>
</tr>
</tbody>
</table>
I’ll probably start to focus more on really ensuring that I have a good understanding of what’s going in the course and worry less about trying to perfect my grades. I won’t completely stop worrying about marks, but they just won’t be my priority.

Some students planned to frame their studies using the good time management and programming habits from their internship to improve their quality of life and efficiency at school. They spoke of structuring work-time routines, removing distractions, and using tools (like mind maps and version control software) to improve efficiency.

After working with managers and team members all summer, many students planned to apply their newly honed communication and collaboration skills at school. They reported better understanding effective project management skills that could be relevant for groupwork in classes and student organizations. Moreover, they valued the connections that these collaborations would bring in terms of deeper relationships and future networking opportunities. Aligned with this increased confidence and interest in communication, students planned to reach out to ask for help more frequently at school.

Another thing that will influence my experience at [school] is interactions with instruction teams. I will probably go to office hours more often as I have learned fairly well how to effectively study better and ask questions.

Among all the themes we saw of students planning to change their behavior after their internships, there was only one that emerged about future career plans. The internship experience convinced several students of the value of passion in their career: they were energized and motivated to work on projects they were interested in. Some students highlighted the ethical implications of their work, and planned to seek out companies whose values aligned with their own. For example:

Out of everything I’ve learned this summer, the most important is that my motivation and productivity lies in the degree I believe in what I’m working on. I don’t think I could ever become motivated to work for a company or on a project that doesn’t reflect my ethics and values.

At the end of summer internships, students formulated concrete plans about their future actions and behaviors. Many intended to change their approach to classes, taking a more active role in shaping their education. Overwhelmingly, students saw increased importance in interpersonal skills and networking and resolved to find opportunities to practice and apply their communication skills at school.

**Quantitative analysis of pre- and post-survey results of educational resources**

As part of the pre-internship and post-internship surveys, we asked students to report what resources they use during their academic studies. These questions were supplemental to the MSLQ questions and are documented in the Appendix. The select-all-that-apply question prompt was “When you study, which resources do you typically consult?” and had the options: The class textbook, Class lecture podcasts (if available), Posted slides from class, Your own notes from class, Videos assigned or created by the professor, Other online videos, Other online resources not assigned by the professor (that you find on your own), The class discussion board, Your friends, The instructor, TAs, and/or tutors, Your previously submitted homework assignments, Other (please specify).

To focus on the help-seeking activities of students, we analyze student selections of three kinds of resources: The class discussion board, Your friends, The instructor, TAs, and/or tutors. We consider whether the fraction of students who reported asking for help from these sources changed after their internship experiences. There were 60 students who responded to this question on both pre- and post-surveys.
TABLE II
TO WHOM DO STUDENTS TURN FOR HELP WHILE STUDYING? AS REPORTED BY STUDENTS BEFORE AND AFTER THEIR INTERNSHIPS.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Number (percent) of students reporting typically consulting this resource (pre-survey)</th>
<th>Number (percent) of students reporting typically consulting this resource (post-survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The class discussion board</td>
<td>47 (78%)</td>
<td>47 (78%)</td>
</tr>
<tr>
<td>Your friends</td>
<td>49 (82%)</td>
<td>52 (87%)</td>
</tr>
<tr>
<td>The instructor, TAs, and/or tutors</td>
<td>47 (78%)</td>
<td>40 (67%)</td>
</tr>
</tbody>
</table>

In the term following their internships, the proportion of students who reported consulting their friends for help with coursework went up. At the same time, the proportion of students who reported asking their instructor, TA, and/or tutors for help went down.

E. Discussion and areas for future research

1) Attitude shifts: Overwhelmingly positive reflection, negative follow-up survey: Our mixed methods analysis found a surprising contrast between the tone of the open-ended student responses and the survey findings. The student response to the reflection question presented an overwhelmingly positive picture of students improving their disposition towards their academic and industry experience. However, the MSLQ survey showed a decrease in average rating for the following questions: “I like what I am learning in my classes”; “I’m certain I can understand the ideas taught in the courses I am taking”; “I think that what I am learning in my classes is useful for me to know”; “my study skills are excellent compared with others in my classes”; “I think I will be able to use what I learn in my classes in other classes”; “I think that what I am learning in my classes is useful for me to know”; “my study skills are excellent compared with others in my classes”; and “I think that what we are learning in my classes is interesting”.

In future work, we may explore possible explanations for the contrast between the open-ended student responses and the post-survey findings. We conjecture that a possible explanation may be due to timing: the pre-survey took place after spring quarter, the open-ended reflection was conducted right at the end of the internship, and the post-survey took place several weeks after the internship. The post-survey took place well into the following quarter and aligned with midterms, which could have been a particularly stressful time. Through the lens of motivation theory [2], we might be able to explain shifts in student reported measure of motivation during particularly stressful academic moments. Similarly, taking the pre-survey prior to the summer internship may be capturing students’ general motivation and excitement right before their internship. Additional work is needed to validate this conjecture, or to bring to light other explanations for the tension we see between the open-ended reflection responses and the survey data.

2) Putting plans into action: who to ask for help?: Both the student reflections and survey findings show an increase in certain types of help-seeking behavior after completing the internship. Students often stated that the internship helped realize the importance of asking questions in the classroom:

I can also try to be more vocal during my remaining time at [school]. During my internship, I did not speak up very often in meetings, even if I had something I wanted to say. This is something that I need to work on overall, and I hope to try doing so in my classes first. My internship has helped me to become more confident in my work, so I am optimistic that I will be able to take more of an active role at [school] and in the future.

When examining who students reached out to for support, the pre-and-post survey results showed an increase in seeking peer support. Students were 5% more likely to ask their friends for help and 11% less likely to ask instructors, TAs, or tutors. The decrease in asking for help from instructors, TAs, or tutors, runs counter to some of the motivation literature and bears further study. The increase in asking friends
for help could be a product of becoming more comfortable with one’s peers and using that network as a starting place for help-seeking behavior.

3) **Developing Interpersonal Skills:** Students described an increased awareness of the importance of communicating clearly and building relationships with supervisors, instructors, and colleagues alike. We coded instances where students were describing a shift in their academic disposition in regards to developing interpersonal skills, and a plan to put these ideas into action in the future. Working intensively throughout their internship gave students tools to collaborate effectively with others and to practice professional networking and communication and an increased appreciation for the importance of these aspects of a CSE career.

4) **Creating Life-Long learners:** Given the nature of our discipline, students must embrace continual learning as part of their professional journey. Internships gave some students their first glimpse of the extent to which working computer scientists and engineers must accommodate changing technologies. Student reflections mirrored this, describing a shift away from simply receiving information to actively creating conceptual connections and choosing coursework and projects that would benefit them in the future. In addition to becoming more proactive in their education, students showed increased metacognition and appreciation for their coursework. Students were better able to both identify opportunities for personal growth and specific classes that could support them in this process.

5) **Lessons for universities:** This examination of the impacts of an internship and its companion course offers potential recommendations for institutions seeking to incorporate undergraduate internships as part of their CSE programs. Throughout the open-ended student responses, we saw the content of the internship companion course reflected back with many students mentioning the core themes of the course: Technical Skills, Personal and Professional Growth, and Ethics & Society. As such, we believe that intentionally structuring a companion course to highlight and make explicit the key learning outcomes of an internship experience can help deliver these outcomes for the students. The 2013 ACM - IEEE Computer Science curricula guidelines [28] can inform the structure of the course through its extensive discussion of our discipline-specific learning outcomes.

There are also opportunities to better leverage student momentum at the end of internships and help capitalize on the lessons they learned. Given the findings from our survey, one way we could support students is to create interventions that help them realize the importance of networking with faculty and TAs. Likewise, sharing this data with faculty and TAs could yield creative results for educators working towards making themselves more accessible.

6) **Future research:** There are several research areas that lend themselves to further investigation. First, we are curious about the demographic distribution of students opting into CSE internships. Disaggregating these data in future studies could present a more complete picture of the representation of different groups in this voluntary (but impactful) internship experience. We could also see if there are nuances or contrasting experiences for different demographic groups.

From the data collected in this study, we are able to make general claims about dispositional and motivational shifts of students that completed an internship. We have not dissected this data to the individual level and connected survey responses with student reflections to see how these experiences are aligned or mis-aligned for each participant. As we continue with this research we will accumulate enough data to devise, implement, and assess informed curricular interventions. These interventions would benefit from additional information about each student to create opportunities for tailored educational interventions to support students in their CS internships, coursework, and co-curricular experiences.
F. Conclusion

We uncovered an array of dispositional and concrete changes that students described after their CSE internship experiences. Student responses highlighted that by working in authentic CSE positions, they grew to appreciate their university experience even more. Further, their internships equipped them with a more thoughtful and deliberate approach towards their studies. By stepping away from the academic context, students were able to more readily see connections between their courses and value more holistically the CSE curriculum. Beyond the dispositional transformations, students left summer internships energized to take charge of their education and motivated to build connections with other students and faculty and apply the lessons learned on the job. The challenge for universities is how to capitalize on this momentum and facilitate opportunities for students to put their plans into action.

REFERENCES

APPENDIX

Pre-internship survey

Before the start of your internship, take a few minutes to reflect on your current motivations and strategies for learning by filling out the following survey. Do not spend too much time on any one question but do your best to be honest and accurate. Base your answers on your CSE classes this past academic year. Your rating should be on a 7-point scale where 1=not at all true of me to 7=very true of me.

Version: 2018

1. Email address *
2. I prefer class work that is challenging so I can learn new things.
3. Compared with other students in my classes I expect to do well
4. I am so nervous during a test that I cannot remember facts I have learned
5. It is important for me to learn what is being taught in my classes
6. I like what I am learning in my classes
7. I’m certain I can understand the ideas taught in the courses I am taking
8. I think I will be able to use what I learn in my classes in other classes
9. I expect to do very well in my classes
10. Compared with others in my classes, I think I’m a good student
11. I often choose classes I will learn something from even if they require more work
12. I am sure I can do an excellent job on the problems and tasks assigned for my classes
13. I have an uneasy, upset feeling when I take a test
14. I think I will receive good grades in my classes in general
15. Even when I do poorly on a test I try to learn from my mistakes
16. I think that what I am learning in my classes is useful for me to know
17. My study skills are excellent compared with others in my classes
18. I think that what we are learning in my classes is interesting
19. Compared with other students in my classes I think I know a great deal about the subject
20. I know that I will be able to learn the material for my classes
21. I worry a great deal about tests
22. Understanding Computer Science topics is important to me
23. When I take a test I think about how poorly I am doing
24. When I study for a test, I try to put together the information from class and from the book or other class resources
25. When I do homework, I try to remember what the teacher said in class so I can answer the questions correctly
26. I ask myself questions to make sure I know the material I have been studying
27. It is hard for me to decide what the main ideas are in what I read
28. When work is hard I either give up or study only the easy parts
29. When I study I put important ideas into my own words
30. I always try to understand what the teacher is saying even if it doesn’t make sense
31. When I study for a test I try to remember as many facts as I can
32. When studying, I copy my notes over to help me remember material
33. I work on practice exercises and answer recommended problems even when I don’t have to
34. Even when study materials are dull and uninteresting, I keep working until I finish.
35. When I study for a test I practice saying the important facts over and over to myself.
36. Before I begin studying I think about the things I will need to do to learn.
37. I use what I have learned from old homework assignments and the textbook or class resources to do new assignments.
38. I often find that I have been reading for class but don’t know what it is all about.
39. I find that when the teacher is talking I think of other things and don’t really listen to what is being said.
40. When I am studying a topic, I try to make everything fit together.
41. When I’m reading I stop once in a while and go over what I have read.
42. When I read materials for this class, I say the words over and over to myself to help me remember.
43. I outline the chapters in my book to help me study.
44. I work hard to get a good grade even when I don’t like a class.
45. When reading I try to connect the things I am reading about with what I already know.
46. When you study, which resources do you typically consult? Select all that apply.
   The class textbook; Class lecture podcasts (if available); Posted slides from class; Your own notes from class; Videos assigned or created by the professor; Other online videos; Other online resources not assigned by the professor (that you find on your own); The class discussion board; Your friends; The instructor, TAs, and/or tutors; Your previously submitted homework assignments; Other:
47. Student last name
48. Student first name
49. PID *
50. Student email *

Post-internship survey

Motivations and strategies: Take a few minutes to reflect on your current motivations and strategies for learning by filling out the following survey. Do not spend too much time on any one question but do your best to be honest and accurate. Base your answers on your CSE classes at [school anonymized for publication] this quarter. Your rating should be on a 7-point scale where 1=not at all true of me to 7=very true of me.
1. Email address *
2. I prefer class work that is challenging so I can learn new things.
3. Compared with other students in my classes I expect to do well.
4. I am so nervous during a test that I cannot remember facts I have learned.
5. It is important for me to learn what is being taught in my classes.
6. I like what I am learning in my classes.
7. I’m certain I can understand the ideas taught in the courses I am taking.
8. I think I will be able to use what I learn in my classes in other classes.
9. I expect to do very well in my classes.
10. Compared with others in my classes, I think I’m a good student.
11. I often choose classes I will learn something from even if they require more work.
12. I am sure I can do an excellent job on the problems and tasks assigned for my classes.
13. I have an uneasy, upset feeling when I take a test.
14. I think I will receive good grades in my classes in general.
15. Even when I do poorly on a test I try to learn from my mistakes.
16. I think that what I am learning in my classes is useful for me to know.
17. My study skills are excellent compared with others in my classes.
18. I think that what we are learning in my classes is interesting.
19. Compared with other students in my classes I think I know a great deal about the subject.
20. I know that I will be able to learn the material for my classes
21. I worry a great deal about tests
22. Understanding Computer Science topics is important to me
23. When I take a test I think about how poorly I am doing
24. When I study for a test, I try to put together the information from class and from the book or other class resources
25. When I do homework, I try to remember what the teacher said in class so I can answer the questions correctly
26. I ask myself questions to make sure I know the material I have been studying
27. It is hard for me to decide what the main ideas are in what I read
28. When work is hard I either give up or study only the easy parts
29. When I study I put important ideas into my own words
30. I always try to understand what the teacher is saying even if it doesn’t make sense
31. When I study for a test I try to remember as many facts as I can
32. When studying, I copy my notes over to help me remember material
33. I work on practice exercises and answer recommended problems even when I don’t have to
34. Even when study materials are dull and uninteresting, I keep working until I finish
35. When I study for a test I practice saying the important facts over and over to myself
36. Before I begin studying I think about the things I will need to do to learn
37. I use what I have learned from old homework assignments and the textbook or class resources to do new assignments
38. I often find that I have been reading for class but don’t know what it is all about
39. I find that when the teacher is talking I think of other things and don’t really listen to what is being said
40. When I am studying a topic, I try to make everything fit together
41. When I’m reading I stop once in a while and go over what I have read
42. When I read materials for this class, I say the words over and over to myself to help me remember
43. I outline the chapters in my book to help me study
44. I work hard to get a good grade even when I don’t like a class
45. When reading I try to connect the things I am reading about with what I already know.
46. When you study, which resources do you typically consult? Select all that apply.
   The class textbook; Class lecture podcasts (if available); Posted slides from class; Your own notes from class; Videos assigned or created by the professor; Other online videos; Other online resources not assigned by the professor (that you find on your own); The class discussion board; Your friends; The instructor, TAs, and/or tutors; Your previously submitted homework assignments; Other:
47. What are three things you liked about participating in CSE X?
48. If you could change one thing about CSE X, it would be ... 
49. The weekly reflections were grouped into three themes: technical skills, ”soft skills”, ethics and society. Which prompts were most thought-provoking for you? (select all that apply) Check all that apply.
   • Technical skills
   • “soft skills”
   • Ethics & society
50. The weekly prompts often had embedded links to articles, blog posts, or videos. If one of these resources was particularly useful or interesting, copy the link to it here. Also, explain briefly why you liked it.
51. Do you recommend any other articles, blog posts, or videos for future CSE X students? If so, copy links to them below.
52. During your internship, did you and your CSE X group members ... (Select all that apply) Check all that apply.
Read and comment on each other’s weekly ... reflections; Have extended discussions on [discussion forum];
Connect on social media networks; Meet in person; Other:
Summer Internship Symposium feedback 53. Did you participate in the Summer Internship Symposium 54. If yes, what was your favorite aspect of the Symposium? ... 55. .. and what is one thing you would change about the Symposium?
56. If no, why not?
Internship feedback 57. Which programming languages did you use during your internship? (Select all that apply) Check all that apply.
Java; Python; Javascript; HTML/CSS; C; C++; Go; Custom company-specific language; Other:
58. Did you feel you were adequately prepared to succeed in your internship? Mark only one oval.
Absolutely; Mostly; Somewhat; Not at all
59. What one piece of advice would you give a student embarking on a full-time internship?
60. If there was one thing you could change about the courses you took before your internship to improve your experience at the internship, what would it be?
61. How did you hear about your internship?
62. Are you doing anything differently this quarter to find internship / full-time job opportunities than what you tried before your Summer 2018 internship?
63. Student last name
64. Student first name
65. PID
66. Student email