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Board 289: Fab Friday and Its Impact on Computer Science Majors' Motivation and Career Readiness

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Fab Friday and Its Impact on Computer Science Majors' Motivation and Career Readiness

1. Introduction

This paper is about a program created to improve the academic success and workforce readiness for low income, high academic potential Computer Science (CS) majors. It was funded by the Scholarships for Science, Technology, Engineering, and Mathematics (SSTEM) program of the National Science Foundation (NSF, Grant #1742618). We focus on preliminary analysis on the impact of "Fab Friday," the centerpiece of our SSTEM program. Fab Friday was an on-campus, semester-long hackathon where our fabulous scholars worked in teams on **Fri**day afternoons to fabricate computing solutions for real world projects and challenges presented by community and industry partners. CS faculty also participated as project mentors. Fab Friday was created to enhance the SSTEM Scholars' social capital, defined as the information and resources generated through one's social relationships and social networks [1].

1.2 The SSTEM Program as the Context for Fab Friday

Our SSTEM program created cohorts of students who were called SSTEM Scholars. They were selected based on being low-income, sophomore status, and academic promise. We conducted outreach to Computer Science, Computer Information Systems, and Software Engineering majors through email blasts; information sessions at various campus centers (e.g., Gender Equity Center, Black Student Center, Latinx Center, Pride Center); and, direct outreach based on student demographics. We strived to solicit the most diverse cohorts possible. Additionally, the National Science Foundation required participants to be US citizens or lawful residents. Once students were selected, the SSTEM program support included receiving a $10,000 scholarship (over four semesters), access to an academic coach, participation in Fab Friday, and community building activities (e.g., social gatherings).

The leadership team directing SSTEM and Fab Friday was cross disciplinary. It consisted of Dr. Youwen Ouyang (CS faculty, PI), Dr. Marisol Clark-Ibáñez (Sociology faculty, co-PI), Dr. Geoffrey Gilmore (Associate Vice President for Student Affairs), and Mae Talicuran (Academic Coach). We are a culturally diverse team (i.e., Asian, Latina, Black, and Pacific Islander). Our unique perspectives and common passion to support students resulted in a strong student-centered collaboration sustained through the grant project (2017-2023).

Our SSTEM program and Fab Friday addressed major challenges facing students. Nationally, there is an equity gap in the graduation rates of CS majors with majority being white male students [2] which then impacts the lack of diversity in the tech field [3]. Locally, CS students at CSUSM had low retention and graduation rates. Our SSTEM program offered support and

exciting forms of engagement to retain and graduate our students at higher rates than CSUSM CS students. See Table 1 for comparison.

Table 1: Comparison of Retention and Graduation Rates for CS students

	2nd year	3rd year	4th year	5th year
CS majors	72%	67%	60%	40%
SSTEM Scholars	n/a	86%	88%	84%

Our SSTEM Scholars apply to be in the program in their freshman year and, if selected, begin their participation in their 2nd year. CSUSM has a relatively high first-year retention rate (77%) that is above the national average (69%) [4]. Retention of CSUSM Computer Science students begins to drop each year thereafter with a four-year graduation rate of 24% and a six-year graduation rate of 45% [5].

Our students are first-generation college students, low income, and primarily students of color. This student population has fewer social networks and understanding of the tech field as compared to students whose parents are college educated and in professions with connections to tech fields [6, 7]. We view our SSTEM Scholars as having significant talent and that they already possessed valuable experiences (e.g., translators for parents, inspired to succeed as role models in their community, resiliency through financial hardships, navigating new social worlds as refugees or immigrants) [8]. Therefore, increasing their social capital would ignite their potential both academically and professionally. Fab Friday provided our SSTEM Scholars a vibrant, challenging, and ultimately rewarding space to enhance their technical skills, practice "soft" skills, and grow their social network through working with students in a team and being mentored by industry partners and CS faculty.

1.3 Design of Fab Friday

Fab Friday was designed innovatively to meet the SSTEM goals of academic success and workforce readiness. Fab Friday provided students with exposure to activities that inspire and sustain interest in the field of computer science. Fab Friday activities sparked motivation while building competencies relevant to the computing workforce. The aim of Fab Fridays was to foster self-efficacy, identity, and awareness of how computing careers can afford opportunities to solve real-world problems and help society. Fab Fridays were held on Friday afternoons with additional self- or group-driven learning taking place in between sessions. SSTEM Scholars were encouraged to participate in at least one semester of Fab Friday.

Fab Friday projects were developed from campus entities, non-profit organizations, government, and industry partners. Examples of challenges included training samples for an artificial neural network used to classify images of plankton; creating a proof-of-concept video management app

for virtual apartment tours; consolidating data from numerous systems (e.g., weight of food deliveries, output, student worker hours) for Cougar Pantry, the university's food bank that addresses students' food insecurity; integrating Alexa to control sprinkler systems; and, creating a cross-platform mobile app for field engineers to record, modify, validate field notes, and retrieve related supporting documents. Scholars typically had two to four challenges from which to choose each semester. In some cases, projects continued for an additional semester.

Additional elements to Fab Friday included fieldtrips to worksites of various industry partners. We also collaborated with the campus career center and alumni to host mini-workshops and career panels during Fab Friday sessions.

At the end of each semester, a public showcase was hosted for student teams to present their projects to campus and community members. Friends and families of scholars would receive a special invitation to attend. Professionals from the university, community, and industry were asked to provide commentary on the projects. By presenting their computing solutions in a public forum, scholars' public declaration of their identification with computer science was a powerful reinforcement of their identity and belonging.

2. Research Methodology

Based on nine semesters of Fab Friday programming, a total of 107 Fab Friday participants completed the Fab Friday Student Satisfaction Survey designed to provide recommendations for programmatic improvement. We measured three major areas: skill building, learning computer science, and teamwork. In addition, we administered the Glynn et al. (2011) Science Motivation Questionnaire (SMQ) [9]. The SMQ provides scores on 5 domains: Career motivation (an extrinsic motivation for learning CS to secure a good career), Grade motivation (an extrinsic motivation for learning CS in order to achieve good grades), Self-determination (an individual's beliefs in their personal control over learning CS), Self-efficacy (an individual's confidence in their ability to learn CS well), and Intrinsic motivation (the innate pleasure of learning CS simple for the sake of learning CS). Motivation has been found to influence persistence of computer science college students [10].

The SMQ was also administered to 527 CS majors who did not participate in Fab Friday. We present the comparative data in the results section.

We collected qualitative data by conducting focus groups with Fab Friday students to solicit feedback on what's working well and what areas of the program may need improvement. This mixed method study continued through the COVID pandemic and created a powerful understanding of student confidence, community, and connection especially through uncertain times.

3. Results

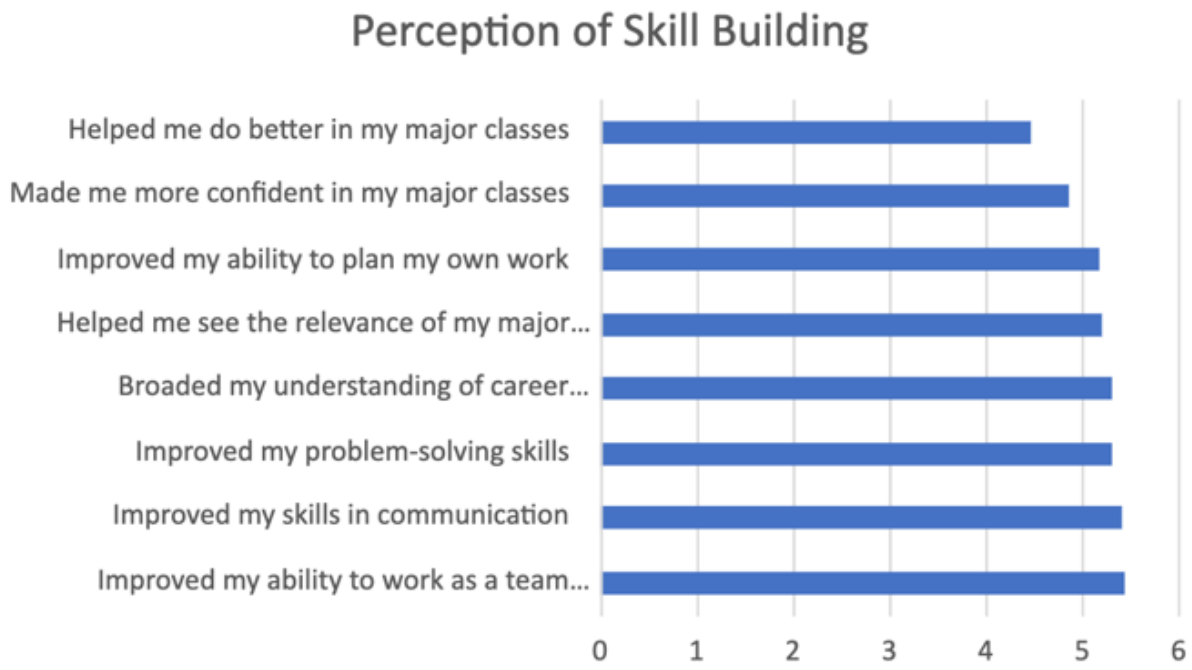
We present three sets of preliminary results. First, we share the outcomes of the Fab Friday student satisfaction surveys. Second, we demonstrate the impact of computer science motivation between Fab Friday participants and CS majors who never participated in Fab Friday. Finally, we highlight student voices (i.e., qualitative data) that provide additional nuanced insights as to the impact of Fab Friday to enhance students' social capital.

3.1 Fab Friday Satisfaction

3.1.1 Perception on Skill Building

Students were asked to rate their level of agreement (scale 1 to 6; 6 highest agreement) to statements about how the sessions helped improve several skills. With a range from 4.47-5.44, most student participants agreed or strongly agreed that activities offered during the Fab Friday were instrumental in supporting their growth. (See Figure 1.)

Figure 1: Perception of Skill Building (Fab Friday Satisfaction Survey)



The highest level of agreement was for improving ability to work as a team member (5.44). The lowest level of agreement was for helping in major classes (4.47). There was a significant difference between these factors indicating that Fab Friday's activities were helpful in developing scholar's ability to work on project teams and not as helpful in improving major courses success ($t=7.70$, $p<.001$).

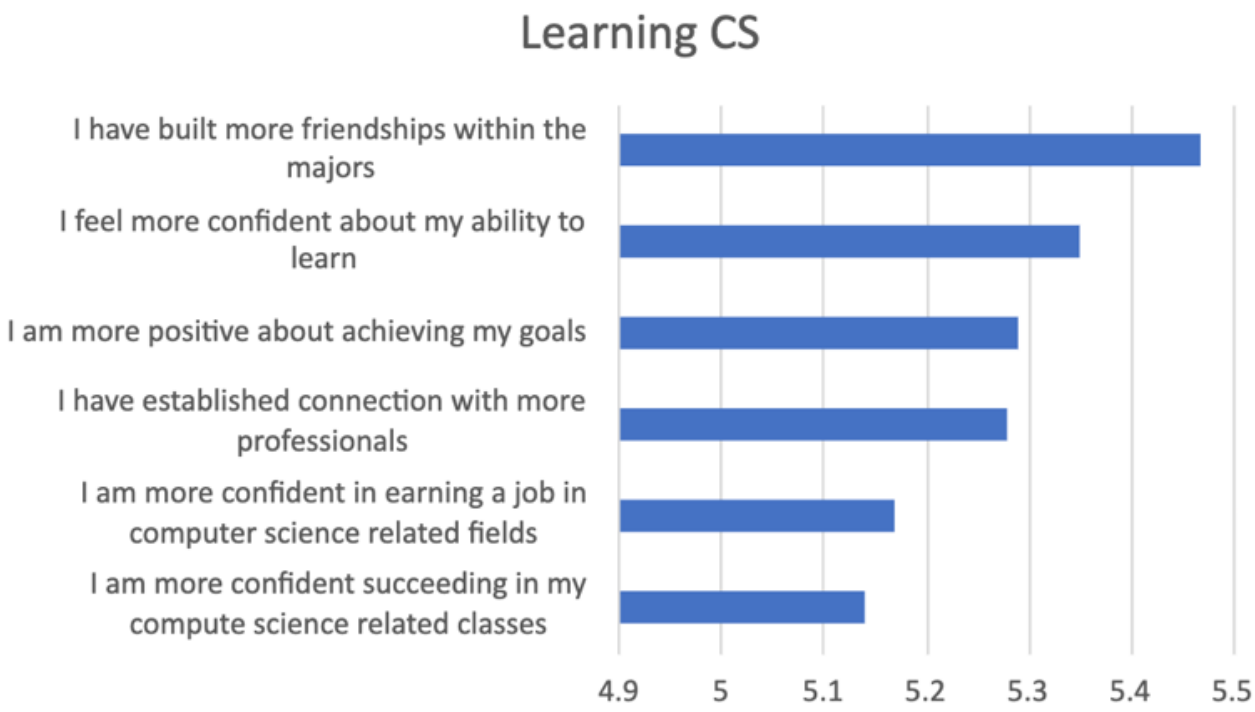
Fab Friday was designed to shed light on the innovations in computer science. More importantly it provided a space for students to learn content that was different than the basics covered in their coursework. Therefore, scholars were often challenged to push their skills beyond what was in their current course curriculum.

The survey revealed other notable findings. Students felt that Fab Friday helped them improve communication skills (5.41), an important soft skill in academic and professional realms. Improving the ability to problem solve (5.32) and plan their own work (5.17) are skills essential for academic success and beyond.

3.1.2 Learning Computer Science

The students rated their level of agreement (1-6 with 6 strongly agree) about learning computer science (Figure 2). The average responses were high. They ranged from 5.14 (confidence about succeeding in computer science related classes) to 5.47 building friendships within the major, and there was a significant difference in levels ($t=3.64$, $p<001$).

Figure 2: Learning Computer Science (Fab Friday Satisfaction Survey)



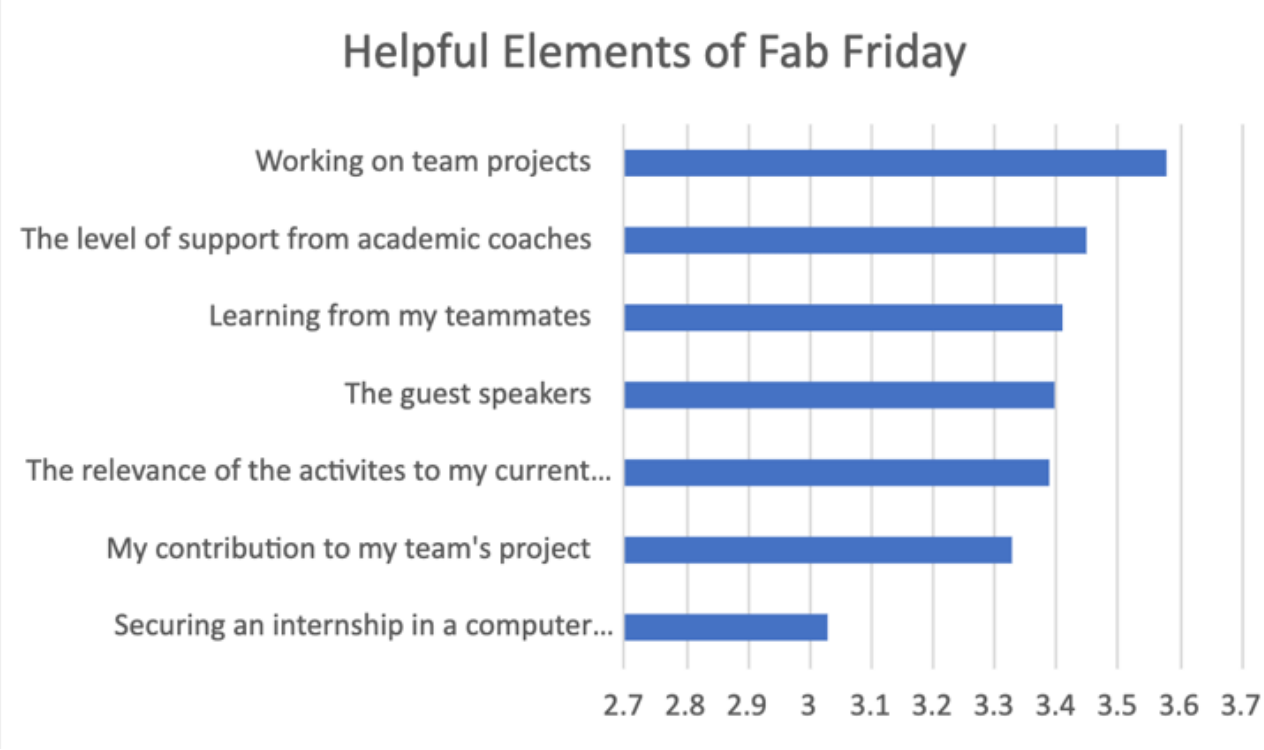
A major focus of Fab Friday was creating the sense of comradery and a safe space for students to learn about computer science. Most students reported that Fab Friday allowed them to build friendships within the major (5.47), which is an indicator of increased social capital. Scholars also felt more confident about their ability to learn (5.35) and achieve their goals (5.29).

Fab Fridays facilitated industry connections for participants who reported benefiting and enjoying the new partnerships. For most students, Fab Friday was the first opportunity to establish projects teams that were solving real world problems.

3.1.3 Helpful Elements - Teamwork and Relationship Building

We asked students to assess the level of *helpfulness* for the various elements in Fab Friday (scale of 1-4, with 4 most helpful). Participants found most elements helpful (range of 3.03 – 3.58), as seen in Figure 3.

Figure 3: Helpful Elements (Fab Friday Satisfaction Survey)



The social connection – through teamwork and faculty – were the most helpful to the students. Results indicate that the most helpful part of the Fab Friday sessions was working in teams (3.58), the support from the academic coaches (3.45), and learning from teammates (3.41). Of note, most students had never had one-on-one interactions with their CS faculty, so working with them to solve real world problems was an incredible opportunity to build sustained relationships. Therefore, Fab Fridays provided growth opportunities for scholars to build their capacity to work on teams and engage in peer learning.

An interesting paradox was that while students highly rated learning from their teammates (3.41), they seemed to slightly downplay their own contribution to their team's project (3.33). As we will see in the qualitative data, students sometimes felt unsure about the abilities compared to others. Thankfully, they also noted that Fab Friday allowed them to see that they were all trying to learn new things together.

One of the factors that facilitated scholar confidence to engage in teamwork was the level of support provided from the SSTEM academic coach. The majority of scholars who attended Fab Fridays reported that the academic coaching received allowed them to envision a path forward in computer science related industries. We also brought in career center advisors to facilitate resume

workshops and career panels. Most reported that Fab Friday career-readiness efforts were somewhat helpful but that more could be done to support placement in an internship.

3.2 Computer Science Motivation

After five years of delivering SSTEM and Fab Friday, we assessed the computer science motivation levels of CSUSM CS majors by using the Glynn et al. (2011) Science Motivation Questionnaire (SMQ) consisting of 25 items [9]. The SMQ provides scores on 5 domains:

- **Career motivation ─** an extrinsic motivation for learning CS in order to secure a good career
- **Grade motivation ─** an extrinsic motivation for learning CS in order to achieve good grades
- **Self-determination ─** an individual's beliefs in their personal control over learning CS
- **Self-efficacy ─** an individual's confidence in their ability to learn CS well
- **Intrinsic motivation ─** the innate pleasure of learning CS simple for the sake of learning CS.

The total possible score for the SMQ is 100 and the max possible for each domain is 20. Each domain was independently scored to compare differences with all CS majors and then between those who participated in Fab Friday and general CS students. To fully understand the differences between scholars who participated in the Fab Friday sessions compared to the general sample of CS majors each domain and overall SMQ scores were analyzed, see Table 2.

Table 2: Average SMQ Scores by Domain for all CSUSM CS Majors Compared to Fab Friday Students

	Intrinsic Motivation	Self-Efficacy	Self-Determination	Grade Motivation	Career Motivation	TOTAL**
CS	14.51	13.78	14.49	15.43	17.85	68.94
FF	15.69	13.21	15.21	16.52	18.66	79.28

Results revealed that scholars who participated in Fab Fridays showed significantly higher overall levels of motivation than the general CS major student sample (t—2.52, p=.012).

There were no significant differences by domain by student group. However, within each student group, there was statically significant difference between the domains. Both groups had the same order of rank. Career motivation ranked the highest for both CS majors and those who participated in Fab Friday. Career interest is something that departments, student clubs/advisors, and associations can capitalize on to engage and sustain CS students in the major. The second highest for both groups was grade motivation, third highest was intrinsic, and fourth highest was self-determination. Self-efficacy ranked last for both groups of students. Interestingly, students

shared in the focus groups that Fab Friday positively impacted confidence in their abilities in CS. We plan to analyze the survey findings further as well as conduct analysis by race and gender.

3.3 Student Voices

Through the qualitative focus groups and open-ended comments on the surveys, the students repeatedly shared that participating in Fab Friday allowed them to grow their soft skills (e.g., networking, social capital, interviewing, resume building) and hard skills (e.g., hacking, programing, software development) beyond their expectations and beyond what they could have imagined. As noted in previous results, there were variations in levels of satisfaction with each of the activities offered with some being favored. Yet every semester, students stated that they would sign up for Fab Friday all over again. In some cases, scholars returned to Fab Friday as guest speakers, mentors, and/or coaches.

Students shared how Fab Friday helped improve social skills (i.e., communication, ability to work on their own and as a team member, preparing for an interview, learning how to manage client expectations). One student reflected, “I feel like Fab Friday lessened the effects of imposter syndrome. We are in the same boat of learning to work in the field.” By learning together, they were able to see that they had a common learning curve, and this was empowering.

As reflected in the previous section, *teamwork* was one of the top skills learned. A student stated, “Working in teams has been really helpful, and we were able to support each other. Even if we were learning something entirely new, we were able to learn it together, and I love how the entire project was based on group effort.” Also, teams allowed students to assume different roles and take on various levels of expertise to contribute to the overall success of the project. This sentiment was highlighted by this student comment: “Fab Friday made me feel more connected. Fab Friday taught us how to be a leader.”

Students also shared how important it was to have mentoring and gain a deepener understanding of career options. A student commented, “Having a mentor really made the impossible feel possible. She helped us immensely while still leaving room for individual discovery.” They also gained understanding about career opportunities (e.g., increased awareness of the endless possibilities within the computer science field). One participant shared, “It was great to get exposure to everything and to start figuring our path.” For some students, being part of this program allowed them to be exposed to firsthand advice on how to succeed in the CS major and college in general. As one student explained, “I don't really have anyone to, like, guide me being in CS so I look to this program for advice to build more connections with people that could help me get into the industry.” Overall, Fab Friday students reported they were motivated to build a network of peers, professors, and industry professionals that they would not have been able to build without Fab Friday.

Many students were able to learn from their peers about what it takes to be successful as a CS major and how to best scaffold learning. The program provided a safety net for students to build their own community. One student shared, “The community is super helpful in providing a support group in which you can actually be vulnerable and again talk to other people to get their experiences and figure out you're not alone.”

Finally, at the end of each semester, participants were asked to share “one word” that best represents the Fab Friday experience. As seen below in Figure 4, the larger the words above the more time the word was shared by scholars.

Figure 4: Word Cloud representing students’ one word describing Fab Friday

The most popular response was that Fab Friday was “motivating” and followed by “active” and “social.” They remarked on the “collaborative” nature of Fab Friday. Students complimented the program by characterizing it as “fun” and “cool.” Students also acknowledged that Fab Friday was “challenging” likely because the experience required a lot of preparation. Other notable words were “growth,” “adventurous,” and “empowering.” Students experienced an expansive sense of their computing identity and a sense of self-efficacy. Taken all together, the word cloud contains the multitude of elements of Fab Friday we had hoped students would experience.

4. Final Reflections

Fab Friday was a safe space to build relationships, ask questions, ignite confidence to increase learning, overcome imposter syndrome, and ultimately to thrive as computer science majors at CSUSM.

Creating and sustaining Fab Friday is an intensive process. The SSTEM leadership team met every week for at least 90 minutes to plan for the week’s activities, check in about the students,

and plan for future events (e.g., social gatherings, fieldtrips, workshops). PI Ouyang coordinated the industry partners, vetted the challenges, and recruited CS faculty to participate. Every Friday afternoon, the SSTEM leadership team helped deliver Fab Friday programming. When needed, team members connected with students or collaborators about specific issues or challenges during Fab Friday.

Perpetual feedback from students and improvement was key to improving the program and remaining nimble through the COVID pandemic. Additionally, connecting with our partners who provided the challenges and debriefing with them on the semester allowed us to further refine our program delivery and build stronger partnerships.

For most students, Fab Friday was the first community and first cohort experience that made them feel like they belonged in the computer science field. Their motivation increased as they worked collaboratively on real world problems. These are essential steps and experiences to prepare them for CS internships and to commence their career.

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