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Shifting Identity Trajectories within a Scholarship Program: Local Community Practices that Shape Computing Careers

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Shifting Identity Trajectories in Computing:
Local Community Practices that Shape Careers in the Field

ABSTRACT

This study is part of a three-year multi-method study of a program serving students in a rural computer science department at a Hispanic Serving Institution. The situative learning theory was employed to understand whether and how students developed interest and agency in a cybersecurity career path. Evidence from the case study suggest that structured, mandatory participation in competitions fueled interest in cybersecurity, as did regular opportunities to discuss contemporary events in the field with students across grade levels and professional interests. Access to a national conference with a hackathon as well as a career fair supported career pathways in the field—the iterative nature of the participation in competitions and conferences gave an opportunity to see growth over time in cybersecurity. The study of community practices may support other educators intending to develop career-focused co-curricular activities that emphasize mutual engagement with other students across grade levels and intent on a joint enterprise, or shared goal. With time and through engagement with more capable peers, students in the study developed shared repertoires of technical language and technical skill specific to a potential career. Focusing on cybersecurity as a subfield shifted the emphasis of identity from one of major choice to one of future possibilities and connection to career. This shift may support future identity work in other subfields of computing, as well as in other elements of computing education, such as graduate study. As computer science seeks to diversify, the act of becoming in computing will be an important avenue of investigation, and the connections students make to specific careers in the field may support identity development that moves beyond the role of student towards future professional identities.

KEYWORDS

Community of Practice, Career Identification, Learning Contexts

1 Introduction

Computer Science and computing career identity are concepts in the computer science educational research field that have seen growth in the last decade, with multiple approaches to its study, from quantitative survey research to qualitative efforts to understand the notion using a range of social science theory. This paper emerges from a three-year multi-method case study that explores how computing students author, or create, computing identities [1] in the subfield of cybersecurity through academic, co-curricular, and extra-curricular practices in a specific post-secondary computer science context.

The paper emphasizes the notion of local communities of practice (CoPs) [2] and identity transformations, or trajectories [3] to illustrate the influence of student agency in situ and to

provide rich detail from student lived experiences regarding cybersecurity and other computing aspirations. Computer science identity can be understood as nuanced, shifting, and dynamic—co-created in interaction and in participation in local activity. The community under study is a cohort-based federally funded scholarship community, which is nested within departmental, institutional, and geographical contexts, and the relevant practice of this community is cybersecurity computing work. Learning trajectories for three students are documented over up to three years of data collection, as applicable for each student. The paper provides implications for studying identity with career-focused subfields as endpoints, rather than generalized notions of computer science as a major. This study conceptualizes identity as dynamic, fluid, and co-constructed. The goal of the paper is to address the following research questions:

1.   How does the local community shape students' becoming (or not becoming) cybersecurity professionals?

2.   What curricular, co-curricular, and extracurricular experiences support student development in this subfield?

3.   What computing career trajectories emerge in Western Tech [program]?

2   Background

This study utilizes a situated learning lens, in which identity development and learning are viewed as parallel processes that occur through interaction and engagement in activity [4]. A situated learning perspective builds from the work of Lave and Wenger [2] and their efforts studying communities of practice (CoPs). In developing this theory, different learning communities were observed and interpreted based on qualitative research methods such as participant observation and interviewing to understand how members of the community deepened their expertise and sense of belonging in a specified practice (e.g., tailoring, managing alcoholism). The Communities of Practice concept was refined to emphasize how CoPs build on three key features- mutual engagement (interactions with others who are building expertise and involvement in a field), joint enterprise (the defining goal or action of the community) and shared repertoires (ways of doing things that become common across members).

In computer science education research, Fincher and Tenenberg [5] utilized a situated lens to describe how the CS education research community is developing as a CoP. While CS education researchers have shown concern that CoP was not a viable theory for discussing traditional forms of higher education [6] subcommunities such as those defined by specific courses in CS higher education (e.g., capstone course development teams, service learning programs in computing) have been investigated using the CoP approach. In this study, the scholarship program serves as a sub-population of the department situated within the department and with access to national and local activity beyond the typical student experience.

Utilizing this theory, the notions of identity and learning are intertwined—as Margulieux, Dorn and Searle [7] put it, "learning is identity construction." (p.216). In this case, the notion of identity is socially constructed and subject to change—while elements of individual identity might be considered "fixed," such as demographic markers, a learning identity within a situative

perspective is in development, with "discourses and practices serving as the tools that build the self in contexts of power" [8].

2.2 Becoming cybersecurity professionals

The literature regarding cybersecurity career interest is not yet well developed, though the research that does exist indicates women in cybersecurity may be at a disadvantage, as stereotypes about who can do computing undermine career advancement [9]. Similarly, research work in the field emphasizes barriers ethnic and racial minorities face in cybersecurity, including bias and discrimination, and posit these lead to lack of motivation to pursue cybersecurity as a career [10]. Other researchers suggest that student employment and mentoring models can be used to successfully mentor women and other students underrepresented in the field [11]. Building community among cybersecurity learners [12] and learning some of the technical content of cybersecurity professions out of class [13] are suggested practices from the literature on cybersecurity learning, which align with the notion of building a professional identity in a technical field.

Mountrouidou and colleagues [14] describe 2 gaps in the research literature regarding cybersecurity education that are addressed in this study—methods for mentoring minority students in the field, and successful strategies for creating equitable access to the discipline. By examining how Western Tech Scholars and their peers become cybersecurity professionals, this paper provides information about "what works" in influencing a diverse body of students to study cybersecurity in institutions that are minority serving.

3   Methodology

This qualitative case study considers the Western Tech S-STEM program as the bounded system [15] under investigation. This section describes the data sources used in this study as well as the data analysis strategies used. IRB was obtained before gathering data.

3.1   Data Collection

Data sources for this study include the following: a) Annual interviews with Western Tech Scholars, occurring between May and October from 2019 to 2021, b) Annual student surveys related to project goals, improvement suggestions, and access to career development, c) Participant observation in S-STEM course activities twice annually, from 2019 to spring 2022, d) Participant observation at the Great Minds in STEM conference, an annual event held in person as applicable (2019) and virtually in 2020 and 2021, e) Participant observation in competitions such as hackathons and National Security Agency competitions, including participant observation in Discord channels related to student participation, f) Eight site visits to the four-year institutions engaged in the grant, including course observation, informal participation in club meetings and work meetings, formal and informal interviews with staff and faculty, and g) Fifteen face to face focus groups with 2-6 students per group over 2 academic years; focus groups included the individual sorting of statements related to cybersecurity based on individual understanding and prioritization of cybersecurity concepts.

One on one interviews were held via telephone or Zoom at the participants' request. All in person participant observation was held in public spaces, such as classrooms and conference spaces. Focus groups were arranged with guidance from staff and faculty, and took place in semi-private areas away from [program] staff and faculty, such as in the student union and in the departmental library.

3.2 Data analysis

The researcher used the constant comparative method [16] to review impressions of the body of data as it grew over the course of the funded project, developing short reports from each dataset and reviewing the findings as they developed through time in the grant. The researcher made extensive use of memoing throughout data collection from the Scholarship sites to document new understandings of student learning and development throughout the cohort-based scholarship program, relying on the notion that high quality qualitative analysis takes place alongside data collection [17].

In year 3, the comparison of participants across sites signaled the initial theme regarding community purpose—while data from Western State Scholars showed an emphasis on building communicative skill and positive peer relationships, data from Western Tech Scholars indicated a community of practitioners developing cybersecurity skill and knowledge through a semi-structured CoP.

As the theme of "Cybersecurity Community of Practice" emerged, the author reviewed the corpus of data with an eye towards the theme, identifying the tools and practices that shaped student trajectories into and out of cybersecurity. At the individual level, Scholars were reviewed across data types and categorized according to their participation in cybersecurity. Three student trajectories were chosen for deeper analysis based on the following factors: data availability for each scholar, demographic underrepresentation in the field of computer science, and diversity of time participating in Western Tech Scholars. Each trajectory is constructed in narrative, chronological form when data permits, and the extensive use of quotes is intended to amplify student voice in the work.

4 Results

The sections below explore the contexts within which the Western Tech Scholars operates— while the case is bound within the programmatic context, other elements of context shape who participates, how they gain access to the community, and the resources and practices available to newcomers and old timers in the community. Section 4 aims to describe contexts and practices while sections 5 and 6 aim to interpret, or make meaning of the community's practices [18] as they relate to professional trajectory and identity development in computing generally and cybersecurity more specifically.

4.1 Context of the case

In a situative study, context is important to understanding identity development and learning as a dynamic process. This section details layers of context of potential relevance to the Western Tech Scholars learning community. All proper names are pseudonyms.

Western Tech is a rural higher education institution in a rural county in the southwestern part of the United States along a major river valley. The town that holds the institution recorded 8,237 inhabitants in 2018, and the population has declined over recent years. The town population is 50% Hispanic, with 15% identified as Native American. In 2019, over 30% of the community lived in poverty, with Native Americans (56%) and Hispanics (36%) living in poverty at greater rates than other racial/ethnic groups.

Western Tech is a Hispanic-Serving institution, which means that greater than 25% of its enrolled students identify as Hispanic. Hispanic-serving institutions have historically been underfunded, under-resourced, and typically lack the institutional capacity to adequately meet the needs of the predominantly Latinx and low-income populations they serve [19, 20, 21].

The institution offers Bachelors, Masters, and PhDs in a variety of STEM disciplines, including computer science, and enrolls approximately 1,200 undergraduate students and 400 graduate students. The average net price for students in 2016-17 was $13,741 for full time undergraduate students. The school is majority white (53%) with just over a quarter Hispanic student enrollment (26%). In 2020, 44 students graduated in the school of computer science. Fifteen identified as Hispanic/LatinX (34%), 6 (14%) as women, 2 (4%) as Native American men, and 4 (11%) identified as Hispanic/LatinX women. Forty percent of the faculty in computer science are women (4 of 10).

There are multiple computing-related clubs at Western Tech, with three emphasizing identities as underrepresented individuals in the field, including the cybersecurity club, the diversity and equity in computer science club, the Society for Hispanic Professionals in Engineering (SHPE), and Society of Women Engineers (SWE). Tutoring is available in the computer science building from near-peers every evening.

Federal grants have supported additional resources in the form of an education center and a research center emphasizing cybersecurity at Western Tech. Undergraduates in the computer science department have opportunities to work in cybersecurity research, outreach to K12 students, and as technicians supporting cybersecurity research. A federal agency supports Western Tech's work to build communication platforms for students engaged in national competitions regarding cybersecurity. As part of the NSF S-STEM grant, additional student activities were enacted for scholarship students to develop them professionally, with a particular emphasis on cybersecurity. Scholarship recipients in S-STEM attend weekly meetings that emphasize practical application of cybersecurity knowledge through competitions, weekly cyber news assignments, and presentations about career-related topics (e.g., building a strong resume).

4.2 Developing cybersecurity language practices, content knowledge

Approximately 25 scholarship recipients joined together via Zoom in the early evening of a weeknight in November 2021. Nearly half of the student participant screens are blank, with half showing faces in dorm rooms, living areas in apartments, and other learning spaces. Phrases scatter the chat- "sorry, internet unstable today" "no video on this machine." The first 15 minutes involve going over the homework, which was one of the group level assignments from the US National Security Agency Codebreakers competition. Students wrap up their questions and the

professor mentoring the Scholars says, "All right, any further questions? If not, let's move on to cyberattacks in the news. So, Josh, could you go first?"

Josh: "Sure. So there's a recent campaign from some threat actors, where basically they were leveraging some Google Ads that were kind of a general make, that once you clicked on it, it was able to compromise the parts of the browser, et cetera, and it would then attack which was the main goal to steal cryptocurrency wallets. Hence, this is an ongoing thing that I'm going to keep reading on, and evaluating, is that cryptocurrency is just, it's an absolute wild west where nothing's as secure as your bank account, and stuff like that. So it's, if there's no security that matches modern day money, it's going to fail really, really fast. So ongoing things happening of basic scans and theft, and stealing energy to crypto mine and stuff, is getting to be a big field."

Mentor Professor: Yeah, I don't know how many of you have crypto wallets, but basically you have to protect your primary key, otherwise the money in your crypto wallet is not secure, so you have to really, really protect wallets for your primary keys. All right, thank you. Jayden?

Jayden: "So a hacker hacked the FBI email system and sent spam emails to roughly 100,000 accounts. Emails went to the recipients directly who were cybersecurity experts…the goal of the attack is not known yet, because here is an attempt to, one, trick recipients into a panic and you shut down the system, two, like a hit piece against the employer, for some reason, and three, to have a lot of the calls to the FBI, and block questions about what these emails mean. Overall, it's just embarrassment that an organization like the FBI could be attacked this way."

The scene above was a vignette of a November meeting held virtually while the professor was on sabbatical off campus, attended by the author. Participants from the newest cohorts of Western Tech Scholars (first and second year post-secondary students) join with those with more experience in their third and fourth years of post-secondary to discuss current events in cybersecurity. The assignment creates an opportunity for students to develop their content knowledge of cybersecurity while trying on the language practices of the field. The two students who presented in the vignette were upper classmen—a fourth year and third year postsecondary student, respectively—and their brief presentations indicate a familiarity with the language of cybersecurity—"threat actor" and "hit piece" in particular serving as vocabulary specific to the subfield of computing.

In community activities, the group is mutually engaged in discussing the timely and dynamic aspects of cybersecurity threats that are relevant in the US context. The mentor professor comments on the current event described and provides feedback related to real world application- specifically, he mentions that individuals need to protect their primary keys to stay safe online with their currency. The second presenter brings in values and reputations of industry and government entities, and how maintaining a strong reputation might influence the ways in which data breaches are communicated with stakeholders. The value of reputation and saving face with regarding to cybersecurity were brought up in these presentations. As new cohorts of students integrate into community activity, they gain access to new language practices, shared resources, and group experiences in the field of cybersecurity.

4.2 Structuring participation in competitions

The cohorts of Western Tech Scholars share multiple sets of assignments in their 1 credit course—one of the practices of the CoP is national competition participation. Competitions are selected each year as assignments for the cohorts, and the faculty mentors structure student participation through regular engagement, assignment of teams based on postsecondary student standing, and weekly check-ins to see how students are progressing. Focus group data across members of the community indicate the team aspect of the efforts support skill development as well as social connection to other Scholars. In one focus group, two participants who identify as central participants in cybersecurity described how their peer was developing quickly during one of the competitions. Their peer remarked how he never was interested in the subfield, but through his teamwork with those with more central identities in cybersecurity, he "learned a lot through trial by fire." Competitions created avenues for immersion in the subfield with more capable others, leading, for some, to more central participation in the work of cybersecurity. The joint participation of all students from S-STEM in the competitions normalized the extra-curricular activity, typically based on self-selection.

5 Career trajectories of community participants

5.1.1 Kevin, cybersecurity professional

Kevin is a Hispanic male senior at Western Tech. He has accepted a position as a cybersecurity professional in Tucson, AZ to begin in the summer of 2022. Kevin grew up in another college town in the same state as Western Tech, and his mother was a program director at the college. This connection to the college meant Kevin attended multiple extracurricular and summer programs for youth in the community with an emphasis on science, technology, engineering, and math.

He mentions he "pretty much lived on campus" growing up, and as a high school student attended an early college high school, so that he took college level courses for his junior and senior years of high school. As a high school student, he got his first glimpse of cybersecurity, and decided to follow that interest into college.

"I wanted to do cybersecurity, so it came down to a school in California and Western Tech, the only school in (my state) that has a cybersecurity focus and a lot of researchers in it, or California, and we all know how expensive California is. So finally it came down to, I'd rather go to maybe a smaller school and not the best and I don't have to take out so many loans. I don't have to worry about that after."

As Kevin matriculated to Western Tech, he took a full-time job doing research with a professor while attending class full time. He described how the work for pay influenced his ability to focus academically, noting how the scholarship improved his ability to excel at school. He also described how the scholarship created a peer network and structured mentoring.

"Yeah, the scholarship has helped me tremendously. I don't think I would have got to where I am without the scholarship, no way. Just having the mentorship, this class through (faculty mentor), having the opportunities to do the career fair, and also having the feeling of a family throughout

everyone that's in the scholarship program, because once we're in the scholarship program and we get to know everyone, talk about anything and give each other advice, versus talking to someone in some random class about advice on our resume."

For Kevin, attending the conference was an important element of community practice—it was an opportunity for personal growth as well as professional opportunity. Kevin met an industry representative and engaged with him through a weeklong competition. This long-term investment of time with an industry team member led to his first internship. He continued his efforts during the school year, secured a second internship, and will work for the company full time in June of 2022.

A statement about providing for others' welfare was the statement about cybersecurity that Kevin appreciated. He described it this way:

"It's probably something to have in the back of the mind, and just something that's also influenced by the news and articles I read, people getting hacked and school districts going down and stuff, and I would hope that in the future, that's something that I would do or put into place to prevent something like that from happening. Just like with the Department of Defense protecting the US and our soldiers and stuff. I hope that my small little effort out of thousands of people would have been something."

Kevin describes his approach to working in the cybersecurity field—staying current.

"Something I do every morning just to stay current with cybersecurity because it's such a changing field, that you have to stay current with it. Because one thing that happened yesterday might not happen today, or something that happened today, yesterday you would have never thought it'd happen today."

5.1.2 Rachel, trajectory from cybersecurity to software engineering

Rachel is a biracial (African American and Caucasian) senior student at Western Tech. For summer 2022, Rachel has accepted a software engineering position with a defense contractor following two internships in the same company. The first internship was in cybersecurity, and the second in software engineering.

Rachel came to Western Tech from a college town in the same state. She arrived with little academic computing experience, though she participated in gender-specific informal learning opportunities in technology in the summers. She describes her path to Western Tech in this way:

"When I had seen Tech (during a visit day) I thought, 'This is what I want to reach out and do, and if I want to try to do something like this, I should do it where it's done well,' But it still wasn't like some crazy, expensive school that I'd be halfway across the country for. So it was kind of a good middle... My finances don't completely dictate where I go to school, but it's definitely a factor."

Rachel found the small school atmosphere helped her in becoming comfortable with her learning environment. Her engagement with female professors early in her academic career at Tech also supported her learning in computer science more generally.

"When I started at Tech, it was actually a lot easier for me because I had two female CS professors right at the get-go, and that definitely made me feel more welcomed into the program. And ever since then, I've been treated exactly the same as everybody else, and I haven't really faced any other barriers since then…. just the fact that it's a small school and you get to know most of the other people in your major. That helps out a lot, too. Because you can bounce ideas off of other people that are working on the same thing."

As a sophomore, Rachel was interested in cybersecurity as a subfield of computer science. In the fall of 2019 she described her career plans in this way:

"Currently I'm also interested in cybersecurity, but it feels like I haven't had much experience with it yet, just with where I'm at in my degree. So I'm honestly not too sure. … To me it seems like fulfilling work. What you do is actually going to matter, it's actually going to protect people. It seems more tangible to me than working on theory or other things like that."

In later interviews, Rachel began to discuss how her experiences with the scholarship program were influencing both her understanding of the cybersecurity field and her interests in the work. Specifically, the meetings Western Tech held weekly, the competitions they engaged in as a cohort throughout the year, and the CAHSI hackathon at the Great Minds in STEM conference were viewed as vital to her development of an inbound trajectory in cybersecurity.

"Honestly, at GMiS I think probably the hackathon (was the most impactful) because that felt like the most... the closest to me getting experience in what I want to do. As far as the most constructively helpful thing, it was definitely the hackathon. So, doing all of that was actually like, all right, here are the kinds of things that cybersecurity professionals do. And here's how you go through and do forensics and things like that."

Rachel earned an internship at the conference career fair with a defense contractor, a company with large representation of cybersecurity professionals. For her second internship with the company, she chose to refocus her efforts in software engineering. Her first summer internship helped her understand her interests were elsewhere.

"I'm working at (Company) as a software engineer intern…This is my second internship with them. Last summer it was cybersecurity, which wasn't really my favorite thing, I learned. That's why I chose (Company) in the first place, because I was like, 'I might be interested in cybersecurity.' I had other offers and I took a pay cut to be able to do it. But that was purely because of the support that S-STEM has been able to give me for school, that I was able to make that decision and find out whether I liked cyber."

Rachel started to shift her emphasis away from cybersecurity after gaining more experience within her local community of cybersecurity practitioners. As a senior in her final year of college, she puts it this way:

"When I first got into it, I thought, oh, 'cybersecurity might be cool.' It was like that whole thing of going places I'm not supposed to and exposing these crazy things. And building these systems to do it. It was a lot less flashy than I expected it would be, I guess. …Because in my experiences with cybersecurity, it hasn't really been any kind of theory. I took a cryptography class, which

was more theory. But, other than that, it's basically 'Here are these tools that other people have made. You're just going to use them. Here's how to use them.'"

5.1.3 Jackson, newcomer to cybersecurity

Jackson is a Hispanic male student, currently a freshman at Western Tech studying computer science. He earned the scholarship in his first year based on financial need and achievement. He attends Western Tech from out of state with a twin brother. He describes the college choice as a "we" decision, yet his interest in computer science differs from his brother's interest in mechanical engineering. Jackson entered the department expressing interest in Artificial Intelligence and Machine learning.

In his first semester at Western Tech, he was recruited to participate in the scholarship program and the faculty research mentor asked if he wanted to participate in research in the lab. He works 5 hours a week. He is beginning to consider his role in cybersecurity.

"Even though I haven't learned much about it yet, it seems like a good fit. The more I learn about it, the more interested I become. It's not something I thought about in the past because I didn't know anything about it."

Jackson has been involved in two competitions to date with his peers—one national hackathon and one longer term competition with individual and group-focused tasks, completed together with his Scholar peers when applicable. The competitions were assignments in the Scholars course. He mentions the competitions when discussing his expertise with cybersecurity to date.

Jackson is intrigued by cybersecurity research—when sorting statements related to cybersecurity he prioritized the statements "Diversity is important in cybersecurity," "Cybersecurity can influence how technology is used in society," and "cybersecurity is a field where academic research is important". He sees the vital role of research in cybersecurity based on the dynamic aspect of the field.

"I'm interested in cybersecurity research as an end goal because I like the idea of discovery. I'm not sure what this looks like yet, but I want to do something new-I want to create something that no one has thought of before."

In spring 2022 Jackson is undergoing "research with the cybersecurity center involving the study of hacking and cybersecurity culture." He describes his current study in this way:

"I'm doing, its not too crazy, but I'm doing a cultural study on cybersecurity about its language use and technical jargon I've been thinking about the language in the field and am making sort of a glossary."

Jackson is beginning his effort by developing a glossary of terms utilized in the field and plans to share his findings locally. The glossary may assist him in taking up the shared repertoire within the local cybersecurity community, which is made up of practices as well as symbols such as language that is particular to a specific professional area.

5.2 Cross case analysis of career paths

Western Tech S-STEM is a community of practice with the expressed purpose of developing cybersecurity professionals at a small rural college campus in the western United States. The engagement of cohorts of students with the content of cybersecurity and with opportunities to develop skills and knowledge with their peers across multiple years of post-secondary study creates opportunity for identity and career development in the subfield of computer science. All students at some point were intrigued with the subfield of cybersecurity—Rachel invoked interest in the hacker culture notion of going where one is not allowed, and shared an initial connection to that idea. For Kevin, the dynamic nature of the subfield was of interest—he describes a lifelong learner approach to the field as important, given the way the field is ever-changing with technological improvements. Jackson, as a first year student, is not clear with his interest in the field. He has an opportunity to study its language and culture with intentionality as a postsecondary researcher —through this work he will deliberately develop (and perhaps make explicit to others in the community) the language practices used in cybersecurity--language that will support more central participation in the field and in the local CoP.

Although individuals engage with the similar activities, and the same group of peers, aspects of their trajectories differ. The value of cybersecurity was viewed differently across focal participants. Kevin connected with the way cybersecurity could help others and provide for the well-being of citizens. Jackson viewed cybersecurity as a field for further discovery through research, and Rachel moved away from the field as she began to view it as a field of application and implementation more than of creation.

6 Discussion

Identity in computing is a nuanced concept—the way in which we conceptualize identity and learning has great consequence for how it is studied. The situative lens can accentuate the nuanced ways community participation can shape not only what post-secondary students are learning but also who they want to become. The site of this work was one not often examined in the computer science educational research literature—a small, rural, Hispanic Serving Institution, and the emphasis of the study on S_STEM programming created an opportunity to focus on economically underserved post-secondary students and their identity development when engaged in a structured community emphasizing cybersecurity careers.

In this study, longevity of the data collection and participant observation was an asset in understanding shifting identities across time for CoP participants. The study of community practices may support other educators intending to develop career-focused co-curricular activities that emphasize mutual engagement with other students intent on a joint enterprise, or shared goal. With time and through engagement with more capable peers, students may develop shared repertoires of technical language and technical skill. Focusing on cybersecurity as a subfield shifted the emphasis of identity from one of major choice to one of future possibilities and connection to career. This shift may support future identity work in other subfields of computing, as well as in other elements of computing education, such as graduate study. As computer science seeks to diversify, the act of becoming in computing will be an important avenue of investigation, and the connections students make to specific careers in the field may

support identity development that moves beyond the role of student towards future professional identities.

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