

## **(WIP) Persistence in an S-STEM project: Understanding the Intersectional Experiences and Identities of Women in Computing**

**Dr. Rachel Funk, University of Nebraska, Lincoln**

Dr. Funk has served as a research scientist with the Center for Science, Mathematics, and Computer Education at the University of Nebraska-Lincoln (UNL) since 2021. She specializes in research about student experiences. Dr. Funk currently serves as the project coordinator and lead researcher of a S-STEM grant seeking to better understand factors that influence the persistence of students in STEM.

**Leilani Marie Pai, Denison University**

Dr. Pai is a Visiting Assistant Professor in Mathematics at Denison University. Her experiences as a mathematician, computer scientist, and mathematics instructor now inform her work in STEM education, where she is interested in equity, inclusion, and student STEM identity.

**Johan Benedict Cristobal, University of Nebraska, Lincoln**

Johan Benedict Cristobal is a fourth-year Mathematics doctoral candidate and student at the University of Nebraska-Lincoln (UNL). His dissertation work is in Mathematics Education, centered around how instructors have framed their teaching and their students' learning. His central research question are how these frames shape how instructors notice classroom events and how culture shapes these frames. Cristobal is currently working with the lead researcher of a S-STEM grant seeking to better understand factors that influence the persistence of students in STEM.

## **(WIP) Persistence in an S-STEM project: Understanding the Intersectional Experiences and Identities of Women in Computing**

This work-in-progress paper uses storytelling to examine the intersectional experiences of four women in computing. All participants were involved in a National Science Foundation Scholarships in STEM (S-STEM) project and identified with a historically marginalized racial or ethnic group. This work contributes to a conversation about potential methods and considerations for such work. We seek to answer the following research questions: How do various settings (e.g., home, university, computing courses, S-STEM projects) support or inhibit the developing computing identities of women who may experience multiple forms of marginalization due to their racial or ethnic identities? How do these experiences influence their persistence?

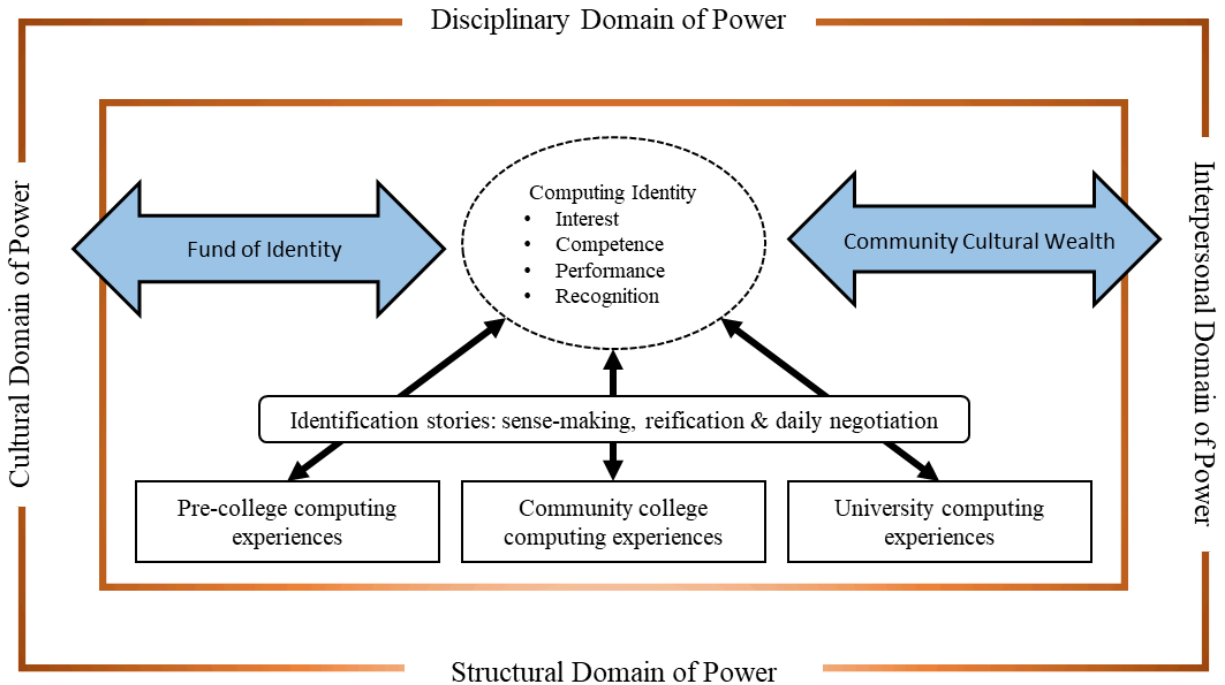
### **Research Problem & Theoretical Framework**

Although the proportion of women and underrepresented racial and ethnic minorities in the STEM workforce is increasing, representation remains an issue in computing and engineering [1]; [2]. A key factor in persistence is STEM identity, and more broadly, the degree to which students feel a sense of belonging at college and within their majors [3]-[6]. Women may struggle to feel they belong in computing due to competitive and identity-evasive disciplinary practices and intersecting stereotype threat [6]-[11]. Increasingly, scholars are adopting an intersectionality lens and asset-based approaches to better understand the experiences of women with multiple historically marginalized identities (e.g., gender, race, class, ability, sexual orientation) and their resilience in the face of compounding marginalization [9]-[13]. Stories are potentially empowering ways of sharing the lived, intersectional experiences and strengths of women—these methods can support investigations into systems of power and sociopolitical phenomena [16]-[19]. Storytelling has been used to better understand gendered experiences of computing [20]. Similar to [21], we examine these gendered stories of computing through a lens of structural power, but with a specific emphasis on computing students and their tellings of times of transition (from community college to university, from high school to university).

Others have argued that identity is a useful analytic lens for understanding the intersectional experiences of women in science [22]. Identities are socially constructed through stories [23]. Such identification stories have explanatory promise in investigating why different individuals respond differently in seemingly similar situations and settings. Building upon [24] and [16], we use the Domains of Power framework [25] to explore students' navigation of computing pathways and settings, and thus the identities available to individuals who navigate these spaces. Within this framework exist four overlapping domains that determine the allocation of power, and thus are spaces in which injustice can take root within computing courses: interpersonal (e.g., microaggressions); cultural (e.g., the masculine default); structural (e.g., access to computing courses in high school); and disciplinary/disciplining (e.g., enforcement of rules). Computing identity development is situated within these overlapping domains. Further, computing identity development is a constant negotiation and sense-making process involving, at the individual level, competence/performance (e.g., knowledge and application of programming skills); interest; and recognition from self and others [22]; [26]; [27]. One's sense of being a particular kind of person changes as they negotiate their identities in different settings, and stories about a person shift from statements about one's actions or competencies ("she codes in Python") to statements about who the person is ("she is a programmer"). When studying the

experiences of non-traditional college students, it is helpful to distinguish pre-college computing experiences from college computing experiences [27].

The model from [27] accounts for both individual and social processes of computing identity development. Originally focused on undergraduate Latinas, we adapt the model to study a broader student population. We also incorporated the Domains of Power framework and centered storytelling as a form of sense-making about oneself. See Figure 1 for our modified version of this model. This model highlights the assets students bring into their computing experiences, which also inform their identity development through times of transition [28]; [29].



**Figure 1: Model for Computing Identity Development**

## Methods

This work-in-progress study, based upon work supported by the National Science Foundation (1930211), investigated how social (e.g., gender, race, ethnicity, generational status) identities influence the persistence of students enrolled in an S-STEM grant that emphasized computing and mathematics degrees. The present study was undertaken to investigate the lived experiences of women in the project, who were disproportionately leaving STEM at the predominately white, bachelor's-degree-awarding institution. Participants include three women computing majors (Diana, Kalani, and Leyla) and one woman who switched from computing to a non-STEM major (Ximena). All participants identified as low-income and used she/her pronouns. Table 1 provides an overview of each participant's racial/ethnic and academic identities.

We applied a data-driven, narrative inquiry approach to identify significant identification stories told by these four participants. Adapted from [30], our interview protocol elicited a STEM life story - including prompting for "highs" and "lows" in experiences of STEM, and for external influences on their trajectory. Participants mostly discussed their experiences in computing, allowing us to refine our inquiry to computing identity. Our interview protocol also included

specific questions about the influences of one’s identities and one’s identification with STEM. Participants were explicitly asked to share their gender identity. We also allowed each to share other identities that were salient to them. Interviews were up to an hour long.

**Table 1. Participant Information**

Pseudonym	Race/Ethnicity	First-Generation	Transfer Student
Diana	Latina	Yes	No
Kalani	Asian American	No	Yes
Leyla	Middle Eastern	Yes	Yes
Ximena	Latina	Yes	No

We conducted analysis in multiple phases. The first two authors independently read through each interview transcript and developed memos with the intent of familiarizing themselves with the participants’ stories. After comparing memos, the two authors developed a summary template for use in describing and analyzing each participant’s trajectory in STEM and computing. Each summary was developed by one of the authors and reviewed by a second author familiar with the transcript. As a team, we reviewed the summaries and connected the stories described therein to our framework. We shared the summaries and a draft of this manuscript with participants and invited them to make changes. Since these stories were potentially sensitive or identifying in nature, we explicitly invited participants to share any discomfort they felt, so that we could remove or aggregate stories as needed.

## Preliminary Findings

### *Developing an Interest in Computing*

Recognition from instructors was a key factor in spurring participants’ interest and identification with computing. For Diana, a high school Photoshop instructor first recognized her potential affinity for computing and encouraged her to take computing courses. For Kalani and Leyla, community college instructors were pivotal in developing their initial interest. Kalani’s high school did not offer many computing courses—when she asked about majors and careers in STEM, she was encouraged to “just stick to art.” At the time, Kalani was also only aware of biology-related STEM majors, which did not interest her. As Kalani entered community college, she was not confident in her ability to succeed in a “hard” major like computing and initially pursued a non-STEM major even though it did not fully align with her interests. These interactions are examples of challenges in the structural domain (a lack of access to STEM courses) as well as interpersonal domain (a lack of recognition from others that Kalani could be a STEM person). These experiences discouraged Kalani, and it was not until college that she began to explore her identity as a computing person. Leyla also did not develop an interest in computing until community college. One of Leyla’s computing instructors, and her eventual S-STEM mentor, encouraged her to pursue computing based on her performance and interest in class. He specifically told her that “every computer scientist” answers questions in the same way that Leyla does and confirmed that she belongs in computing. Leyla reflected, “imposter syndrome wasn’t a thing that semester.”

Each participant reported that her family was supportive of her pursuing a STEM degree. For Diana, a first-generation student, interest in STEM began early—reinforced by her parents’ value

of education and STEM: “Since I’ve been a kid, there’s always been that STEM influence in my life.” Families were also supportive of Scholars’ well-being more generally.

### *College Experiences in Computing - Low Points*

All of the “low” points described by participants occurred at the university. Each participant remarked on the low representation of women in their computing programs. Kalani described being one of only two Asian women in her introductory computer science course and struggling to find peers in her major despite appreciating the connections made in a S-STEM project: “I do have the [S-STEM community] here, you know, to open me to opportunities and have people to talk to. But then finding people on my own, it feels more individualized.” Diana described changing majors within computing because her classes were dominated by white men and she did not feel supported. At one point, she tried to make friends with a coworker who was also in her program. Diana said, “He made a comment about how I would only be successful in the career just because I am the diversity quota, and that all the things that [I had accomplished]... is just because they needed the diversity person.”

Beyond facing challenges in interpersonal interactions with peers, participants identified hurdles related to the structural and cultural domains of power. Kalani and Diana struggled to transfer college credits into the university’s degree plan. Diana felt dismissed by advisors, and struggled to belong in her major. She later found an advisor who supported her success and helped her switch to a different computing major. Yet, her experiences in computing did not change significantly. Rather, Diana expressed the continual pressure to fragment her identity in order to “feel safe” in computing, and employed a number of strategies to be successful, such as purposefully speaking quietly to not be labeled as a “loud, annoying Latina” and seeking community in a non-STEM minor and student groups.

Diana and Leyla both experienced their lowest points at a time when they lost close relatives. For Leyla, this experience was compounded with the feeling that she was not given time or support to grieve. In addition, she had been fighting feelings of inadequacy in her computing course when she could not answer her professor’s cold call impromptu questions, but her classmates appeared to do so easily. The lack of institutional structures to support bereaved students made her feel she had no power to assert her right to grieve. For Ximena, her lowest point was during her first computing course where she was accused of having suspiciously similar code to another classmate. Though she knew she had not done what she was accused of, Ximena said, “I wanted it to just go away,” and so confessed. Ximena’s case demonstrates how power is exerted through the disciplining domain—she was accused of breaking the rules and regulations of academic integrity and felt pressured to confess. This had an incredibly damaging effect not only on Ximena’s computing identity, but her overall mental health: “everything that happened to me changed me as a person. I used to be stronger.”

### *College Experiences in Computing - High Points*

Diana, Kalani, and Leyla all shared stories of “high points” in their experiences of computing following the start of college. These experiences were often connected to stories of receiving external recognition or having opportunities to perform as a computing person. For Diana, high points were being accepted into an undergraduate research community of scholars that funded her to do computing research and attending STEM conferences (some of which were supported

by the S-STEM project). Similarly, Kalani applied to and received a STEM fellowship grant with the support of an S-STEM faculty mentor. This grant allowed Kalani to work alongside her faculty mentor on a computing-related project. Kalani chose a topic outside of his expertise, but he happily acted as a student alongside Kalani—researching the topic to better support and follow her journey. This redistribution of power between mentor and student had a powerful impact on Kalani's identification with computing.

As for Ximena, despite a number of negative college experiences, she continued to have an interest in computing and “wouldn't mind going back into it years later.” Her priority is graduating and putting her experiences at the university behind her. This suggests that Ximena has maintained a computing identity (interest in computing) despite not persisting in her computing degree at this particular institution.

### *Stories & Critical Consciousness*

Participants rarely interpreted their stories in relation to larger systems of power until specifically asked to reflect on the role of gender or other social identities to their journey in STEM. All participants shared stories about their personal experiences of microaggressions from peers and instructors in computing, recounted stories from their peers, or shared cultural stories about women's struggles in STEM. Leyla described how women have “greater pressure” to prove themselves “just because of the past and how women have been perceived in computer science.” Kalani and Diana both feared experiencing microaggressions in their future workspace. Kalani voiced: “I could encounter bias and could encounter... where I miss, or I don't get an opportunity because of my gender or because of my ethnicity.” This anticipation of potential structural and interpersonal oppressions in their post-university computing experiences was a common theme among participants, suggesting that stories about the struggles of women in computing contributed to participants' sense making of their own (including future) computing experiences.

### **Discussion Points for the Session**

In this work-in-progress paper, we use an intersectional lens to share significant identification stories from four women in computing as a means to better understand institutional sources of marginalization and the persistence of women beyond these challenges. As we continue this study, we have several questions to consider:

- What are ways we can more fully engage participants in this analysis and presentation of results from this work?
- How (and to whom) should implications of this study be communicated to support changes in institutional and departmental practices?
- What implications do these findings have for S-STEM projects, or similar programs and their efforts? All participants viewed the S-STEM project as a resource. Community colleges, and in particular S-STEM faculty mentors at community colleges, can play a critical role in developing interest in computing. That said, despite focusing on computing and mathematics, some participants did not feel as though the project helped them make connections to peers in their major.
- We build on theories grounded in specific identities (e.g., Black feminism), yet we extend these theories when considering the experiences of women who identify with multiple different racial and ethnic identities. Is this an overextension? What are methodological/ideological considerations for engaging in such work?

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