Taking management into our own hands: How computer departments promote inclusivity and empower students

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Introduction

In the coming decade, computing careers are expected to grow at a faster than average rate (Bureau of Labor Statistics, 2015), yet women and some minority groups have historically been underrepresented in these high-status positions in the knowledge economy. Accordingly, calls for social justice and equal access to opportunities in scientific and technical fields, including computer science, have increased in recent years. Despite the growing demand for technically trained workers, the underrepresentation of Hispanics in computing is a grave concern. Hispanics are the fastest-growing ethnic group in the United States, yet lag behind all other racial/ethnic groups in college degree attainment (Education Trust, 2018). The inequities in computing disciplines have been slowly improving but remain grim. For example, only 10% of baccalaureates and less than 5% of doctorates in computer science in 2015 were granted to Hispanic US citizens (National Center for Education Statistics 2018), even though Hispanics comprise 18% of the total US population and 25% of the youth population (US Census,2019). Our focus on computing disciplines is particularly relevant because there have been recent calls to better understand the distinct disciplinary cultures and processes within the broader STEM umbrella (National Academy of Sciences, 2016).

The Computing Alliance of Hispanic-Serving Institutions (CAHSI) implements a number of successful pedagogical and structural innovations that support the recruitment, retention, and advancement of Hispanics in computing (see Gates et al., 2011; Thiry, Hug & Weston, 2011;

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Thiry & Hug, 2013). CAHSI is a National Science Foundation-sponsored network of computing departments in Hispanic-serving institutions (HSIs) that works with industry and other partners to share resources and align strategies to address the social inequalities and structural barriers faced by Hispanic students in computing fields. The alliance has achieved success in recruiting and graduating underrepresented students in computing and has surpassed the rates of peer institutions (see author, 2011). The goal of this study is to investigate how departmental culture and practices promote the success of students in HSI computing departments. Our research question is: *How do underrepresented students in computing form discipline-related identities and what are the departmental practices that support this process?*

Conceptual Framework

We use Holland, Lachicotte, Skinner, and Cain's (1998) concepts of identity and figured worlds to illustrate the experiences of underrepresented students within computing majors. Identity development is significant for underrepresented, or subordinated, communities, such as Latinx in computing. According to Holland, et al. (1998), people may either reproduce or challenge social and cultural constraints through the process of identity development. Identities are works in progress that are formed in and through everyday social practices and relationships. While this notion of identity allows for agency within peoples' lives, actors are constrained by given social, economic, and historical conditions. Within these conditions, people may "improvise" and act creatively to subvert or transform social or cultural inequities, such as underrepresentation in computing.

Identity is formed within certain "figured worlds," through routine interactions, activities, and relationships. Figured worlds are socially and historically situated realms of human activity with their own sets of values, norms, and expectations. Figured worlds may be broad, such as the discipline of computer science, or local, such as a student club within a computing

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department. People enter into or are recruited into figured worlds and they "come to identify themselves as actors of more or less influence, more or less privilege, and more or less power in these worlds" (Holland et al, 1998, p.60). The concept of figured worlds allows us to examine hierarchy, status and power within specific cultural realms such as academic departments. In this study we employ figured worlds to understand how underrepresented students negotiate academic paths and construct identities in computing disciplines.

Methodology and data sources

This study is a multi-site, descriptive case study of departments that have been successful in retaining and graduating underrepresented students in computing. A case study of exemplary computing departments allows for deeper inquiry and understanding of student pathways and identity development within real-world departmental and disciplinary contexts (Yin, 2003). We conducted week-long site visits to five CAHSI computer science departments that were selected because they were the most senior members of the alliance. During these site visits, we conducted semi-structured interviews to investigate the complex behaviors, interactions, and social processes involved in students' experiences within the figured world of computing (Fontana and Frey, 2000). Additionally, we conducted classroom observations of 32 introductory computing courses/sections on the five campuses (which will be reported in more detail in the conference paper) using the Teaching Dimensions Observation Protocol (TDOP) observation protocol (Hora, 2015; Hora & Ferrare, 2013) in conjunction with ethnographic field notes (Spradley, 1980). In all, we interviewed 28 faculty and department chairs and 127 students in the five departments. Interviews lasted 40 to 75 minutes, were digitally recorded and transcribed verbatim. The vast majority of student interviewees were Latinx and, although women are severely underrepresented in computer science, they comprised nearly half of our interview sample. We interviewed 18 student leaders individually (typically juniors and seniors)

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and randomly selected students enrolled in introductory computing courses (typically freshman and sophomores) for focus group interviews (22 interviews in total), comprising from 3 to 10 students. Student interview protocols explored their backgrounds, interest in computing, departmental experiences, trajectory in computer science, and the factors that have shaped their computing identity. Faculty interview protocols explored teaching approaches and methods, interactions with students, and departmental resources and supports for student retention and diversity.

Analysis methods

Interview transcripts were coded using domain analysis (Spradley, 1980). Researchers searched for units of meaning within the data, coding interview transcripts for examples of "cover terms." Domains were then constructed linking theoretical concepts to coded examples through a semantic relationship such as 'is a kind of' or 'is a way of doing'. Codes were generated both deductively, based on our research questions and our theoretical framework, such as computing disciplinary identity, and inductively, based on emergent themes from the data, such as activist identity. Two researchers coded the data and regularly discussed research findings to enhance inter-rater reliability.

FINDINGS

Empowering Peers

Because many students were first-generation college students, commuter students, and often had little background in computing, peer support and help were critical to students' identity development and academic trajectories. Novice students benefited from academically oriented peer support that helped to deepen their conceptual understanding of computing and strengthened their identification with the discipline, and they also benefited immensely from

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providing this support to their peers as they advanced in their degree program. Students provided academic support through tutoring, peer-led team learning and informal study groups.

Students also provided professional and career support to each other. For instance, students communicated with each other about internship and research opportunities, job interviewing and resume skills, and provided educational and career advice. Most students reported that peer support was essential in developing a computing disciplinary identity, as described by a Latinx student in an advanced computing class: "*For the first few semesters I would go to the library in the back and sit by myself and I would be afraid of all these advanced students… that they're going to criticize my code and then I got to know them a little bit better and they're just a great bunch of people really wanting to help each other and that really helped me and ... now I'm a few months away from graduating and I find myself the mentor and the teacher of other students."*

Students felt a sense of leadership, responsibility, and a desire to "give back" to their peers and some of them deliberately undertook a more activist stance to lift up Hispanics or women in computing fields. A student described how she felt uncomfortable with computing at the beginning of her studies because she had little background in it. She decided that other women might also feel uncomfortable and started an academic computing club for women in her department to increase their sense of belonging, stating: *"I'm just trying to offer resources and trying to engage women in the CS department, and try to make them feel less insecure about certain things. 'Cause sometimes, they're like, "Hey, I feel left out or I feel like I don't belong here". 'Cause I've had classes where it's a room of 200 people and there's seven girls. And it's like even though it's rising, it's slowly rising. So for us to make that big, giant gap, we, as students, I think that we should take management into our own hands and try to recruit girls."* As Holland et al., (1998) theorized, the social interactions in the localized and temporal space of

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the new computing club gave voice to the lived experiences of Latinas in the broader figured world of computing. In this way, the women's interactions and activities within their local figured world allowed them to enact a more empowering computing identity and interact with peers similar to them who could provide support in the alienating landscape of computer science.

Creating the Conditions for Inclusive Peer Environments

While students drew on peer support to craft identities in the figured world of computing, peer communities were not necessarily formed by accident or happenstance. Departments had enacted many programs and practices to foster inclusive, positive environments inside and outside of the classroom that created the environment where students could freely enact empowered computing identities. For one, the departments formalized the professional support that students provided to each other by creating a student advocate position within each department. Advocates were paid to inform their peers about opportunities and resources and to be a student leader and role model within the department. Most of the departments have also implemented peer-led team learning in which peer leaders assist students in introductory courses with supplemental activities and instruction both inside and outside the classroom. The departments also actively encouraged and sponsored student clubs where students can engage in professional practice, such as mock interviews, and build peer community. Because of this culture of encouragement and community, students felt empowered and comfortable in forming their own student organizations, such as the women in computing club. Several departments also held out-of-class challenges and events, such as hack-a-thons, where students work in teams to solve a problem. Students reported that they met friends and felt more connected to the department through these events.

Besides clubs, events, and programs, departments also provided the means for students to informally build community. For instance, departments provided student study or lounge

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space with tables, chairs, and white boards where students could come together to work on problems or study together. Providing physical resources was very important for community building in departments where the majority, if not all, students were commuters and many worked outside their studies. Because of the complexity of students' lives, departments had to deliberately and intentionally take steps to cultivate peer community. For example, faculty also ensured that students would meet like-minded peers by facilitating introductions between students with common interests and integrating cooperative learning in computing courses. As a Latina noted, *"The biggest challenge is finding a group to work through all the classes together with. Because, if you don't, you tend to start slowly falling off or disappearing. [The faculty] has been really good about getting students to work together, getting to meet each other and become friends."*

Conclusion

Everyday interactions and relationships among peers served to foster peer community and helped students to craft disciplinary-based identities that strengthened their commitment to computing. These interactions were academically and professionally oriented, yet also provided essential social networks for students with little to no incoming social capital in the figured world of computing. Yet this supportive peer culture was in many ways assisted by thoughtful and deliberate programs and activities within the computing departments with the goal of addressing inequities through systemic change. In conclusion, this study demonstrates the significance of peer community in non-dominant students' identity development in technical fields and highlights some of the ways in which a successful department cultivated an inclusive peer learning environment.

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