

Borderlands First-Generation-in-Engineering Experiences-Learning with and about Students at the Nexus of Nation, Discipline, and Higher Education

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Abstract:

Educational contexts are complex in the ways they support and fail to support student success in engineering. In border communities of the southwest, where rural communities blend across national and state boundaries, student counternarratives of educational success involve complexity. In particular, engineering students' descriptions of language, familial backgrounds, disciplinary knowledge, hidden curriculum of US post-secondary systems, and financial services built for citizens OR international students indicate there is much to be learned about how institutions in border communities support or fail to support equitable access to engineering pathways. In a larger study, transcript analysis of 40 interviews from undergraduates at a border institution indicate scholars navigate familial and background difference across educational levels (i.e., first generation status), educational systems (e.g., educational background in Mexico compared with educational background in the United States), disciplinary differences (e.g., rigors of engineering in terms of time commitment compared with other majors). In this exploratory, work in progress study, we aim to illustrate how scholars who participate in a National Science Foundation-funded scholarship program navigate learning at the nexus of nation, discipline, and higher education systems. We developed brief counternarratives, or stories that tell truths from non-dominant perspectives about how students navigate academic pathways in the computer science department. The authors identify how the counternarratives point toward needed policy and practice change in the department and hope to gain feedback from the EQUITY community regarding our efforts and next steps at *Praxis*, sharing these counternarratives in departmental spaces to draw out faculty, staff, and student dialog toward change.

Introduction

In this work in progress (WIP) research paper, we examine pathways of post-secondary engineering students who are first in their family to attend college in the U.S. navigate multiple obstacles on the way towards four-year degrees and graduate school pathways [1]. Literature regarding students who are first in their family to attend college indicates that while the absence of the legacy of college may serve as a logistical barrier to success in higher education, other

assets can be used to leverage resources available to forge careers in engineering [2]. Students studying engineering in the borderlands experience additional hardships when navigating higher education, as they manage tensions across disciplinary expertise, culture, language, as well as physical borders of state and nation [3]. In this work in progress paper for the EQUITY group in ASEE, we offer counternarratives of student experiences as possible resources for social justice work in local departmental contexts. The questions that we pose in our session are:

- A) How can constructed counternarratives of student experiences guide departmental dialog about equity and inclusion?
- B) How can faculty and staff serve as co-conspirators in the support of student undergraduate retention, and advancement to graduate school? And
- C) How can counternarratives of student success serve as resources for peer success?

Counternarrative as a research praxis vehicle for change

Hegemonic scripts are the taken-for-granted concepts that underlie mainstream Western thought and build cultural ideals, particularly in high education and other systems [4]. Two concepts that serve as hegemonic scripts in STEM higher education are meritocracy and scarcity [5]. Meritocracy is the myth that those individuals who work hard in school are successful, and earn the accolades that come with academic success. The scarcity model is the notion that a limited number of individuals are deserving of high-quality education in the STEM fields, and that one feature of higher education practice is the filtering of those worthy of learning STEM in higher education [6]. Evidence from higher education research more broadly indicates these hegemonic scripts are embedded in post-secondary institutions, and that faculty and administrators may have these scripts embedded in their own understanding of schooling [7].

In contrast, engineering and computing departments could embrace counter scripts [8], the alternative notions that privilege equity, inclusion, and social justice. Counter scripts relevant to this work are pedagogy of empowerment, in which learners are encouraged to question policies and practices that do not serve them, and education for social justice, which rejects the notions of scarcity in education, as well as the notions of meritocracy—an understanding of systemic racism in education inherently discards the myth that only those who work hard get ahead.

Counternarratives juxtapose hegemonic scripts of higher education practice with stories that are strengths-based, and emphasize alternative perspectives [9]. Counternarratives have been shown to expand students' conceptions of careers in non-traditional fields [10]. Sharing stories from "othered" perspectives can illustrate systemic racism and sexism at play in educational contexts, and can suggest policy and practice-based solutions [11].

Method:

This paper is part of a larger study investigating the ways in which a scholarship program serving computer science 2 year and 4-year programs at Hispanic Serving Institutions in a rural Southwest state was developed to support students, particularly Hispanic first-generation college

students, as they navigated higher education pathways in computing. The table below provides additional information regarding the data sources that support meaning making in this project.

Demographic Marker	Source of Data
Gender identity	Survey distributed by (source of grant funding)
Race/ethnic identity	Survey distributed by (source of grant funding)
Citizenship/permanent resident status	Survey distributed by (source of grant funding)
Place of birth	Survey distributed by (source of grant funding)
Pell eligibility	University records, program application
Transfer status	University records, program application
Language experience	Interview data, participant observation and informal interaction with program participants
First generation college student status	Survey distributed by external evaluator
Year in school/expected graduation	University records, program application

Interviews were held annually with scholarship recipients in their sophomore, junior and/or senior years during their enrollment at the four-year institution using semi-structured interview protocols. All interview participants take part in a scholarship community- the main component of the community is weekly meetings with the staff program manager as part of a one-credit course. Participants meet over the course of the scholarship, and participate in professional development and community building activities related to the computing major. The program manager serves as an author of this paper.

The authors serve multiple roles in the program and in the department—the triangulation of data, of analyst, and of data type supports development of findings and counternarrative development. Thematic analyses were conducted for related work [12] that covered themes across interviews, and documenting student demographics more holistically. In reviewing individual interviews, however, it became clear to staff, social scientists, and administrators in the grant that the narratives of students themselves had value, and could be leveraged to appeal for equitable policies and practices in a computing department. In particular, the perspectives of first generation LatinX students from the target department were drafted based on transcript interviews as well as author knowledge of the students highlighted in the stories. Counternarrative findings and policy implications were triangulated through additional fact-finding; for example, transfer policies at the institutional and departmental level were investigated with document analysis.

Upon review of the counternarratives, authors who inhabit differing staff, social science, and administrator positions within and outside the department considered practice and policy implications of the counternarratives shared, documented in the discussion section of this paper. In the implications section, we draw out potential scenarios for use with departmental groups. Following the guidelines in the call for submission to ASEE EQUITY we will refrain from “one-way presentation” and offer discussion questions for the ASEE EQUITY community to tackle regarding counternarrative engagement as a strategy for social change. The work in progress paper focuses on two pillars of the ASEE EQUITY division, specifically *examining systems* and *theoretical perspectives*.

The authors’ positionalities are as follows: Latina departmental staff member with STEM background and graduate degree, US born, originally from a border town in a neighboring state; Latina Mexican national postdoctoral scholar with a computing and education PhD background; Latino staff member who is a US citizen born in Mexico with social science background; Caucasian man of Italian descent with an administrative leadership role in computing; and Caucasian woman and US citizen with a social science and education background.

Counternarrative A, Katrina*

Katrina began her academic career in community college with a focus on physics. Her interest in physics did not wane, but she did have a realization that a Bachelors degree in physics was not one that led to careers in the field—she decided she was not willing to get a PhD in physics, and that a computer science four-year degree was a safer bet for employability. To pay for school she worked full time out of high school and saved money for college. In her first semester as a community college student, she worked full time, then in her second semester she took off of work because the workload was too much. As she completed her associates degree, she chose to attend the target university- she was able to make that work because of a policy that allows individuals from nearby states to attend at near-in-state tuition rates. Her commute has been an hour in each direction each day during her junior and senior years.

As a junior transfer student, Katrina described feeling like all of the other people in her CS courses “have these secret meetings and they just know things” even in early coursework. She was very aware of her outsider status as a woman in the field—in most courses she experiences 20% women on average, and that difference causes her to try to, as she describes it, “represent well” as a woman in the field. Her first semesters in computer science coursework came during the height of the COVID-19 pandemic. As a transfer student, she was missing connections faculty were making to previous coursework at the university, and her background at a community college seemed to hold her back. She describes faculty as having a closed door policy to support—“if you knock they will let you in and answer,” but they do not all encourage faculty-student interaction. Katrina states her parents cannot help her with school because of their lack of higher education experience, but she has found a community of support at school.

Katrina relies on peer support for academic success. Katrina sees her scholarship community and program leader as a strong support system—she expresses a sense of kinship with the program manager based on his connection to her culture— “I feel like our ethnicity, our culture, the

Hispanic kind of aspect (connects them). I feel like he also understands because he's been in the trenches of being Hispanic too." As a Latina, Katrina attended a conference focused on diversity in STEM, with an emphasis on Hispanic/LatinX populations. Her experience of the career aspects of the conference were disheartening—she noticed that the students who were earning the internships and job offers were not the minority students but those of the majority who also were encouraged to attend the conference. Katrina also noted the ways militaristic career paths were on offer more than other computing paths—she notes that she is a citizen and is therefore eligible for cybersecurity work that requires clearance, but her interests lie elsewhere. As Katrina navigates the computing career path, she considers graduate school to increase her knowledge before heading into the workforce.

Counternarrative B, Ernesto*

Ernesto grew up and went to high school in a large city in Mexico along the US border. As a senior in high school, he had considered architecture as his career path—upon further investigation, however, he learned the job market was difficult for early career architects. His uncle worked in the states as a computing professional, and suggested Ernesto might be well-suited to the field based on his gaming interests. Ernesto began to do research on the career options, learned about his uncle's earning power, and chose to major in CS. He began his BS at the height of the pandemic, and chose to focus on his general education requirements during online coursework, as he did not think he would be able to learn CS well in an online environment. He became somewhat behind in coursework based on this choice, as the CS courses require pre-requisite knowledge and cannot all be taken concurrently. As Ernesto began to learn about CS as a first year major, his interest was piqued by the introductory course, in which the faculty member was energetic and showed interest in supporting student learning. Since that first course, Ernesto noted a change in faculty support—in fact, in CS1 Ernesto was told to find help outside of class because the faculty member was not able to assist in his learning beyond class time.

Ernesto described finding friends as a source of support based on his experience in the S-STEM program—this sense of community flourished in his third year as a student at the university. He considers his own introverted nature and his self-consciousness about his English as possible factors that impacted his sociability in the department early in his schooling. Ernesto views the department as one that can, at times, feel inclusive. "When I start seeking help and see that there are many students like me that may be having problems or look the exact same way or they have similar roots like, "Oh, they're Hispanic too", "Oh, they're Mexican too." Or, "they're also learning English". Because English is my second language, as of right now. My first language was Spanish. Also seeing the variety of people that are in CS, not only Mexicans but maybe from India, or maybe from the US, maybe from other countries, it also helps me feel included. So at first, I didn't feel included that much, but now that I'm just in CS courses, I definitely feel like I'm a part of this CS community." Ernesto is most motivated to succeed in computer science based on the support of his mother, who always wanted him to get a college degree, his uncle, who mentors him in the field of computer science, and Alec*, a staff member at the university who supports his retention in the field by encouraging career readiness. Ernesto

wants to earn an internship in the field, yet his citizenship status prevents him from accepting an internship in coming months, until he is a naturalized citizen, a process he cannot start until his 21st birthday, in June following his third year in college. Ernesto's proudest accomplishment has been staying positive about his future in computer science, despite obstacles.

Discussion: Policy and Practice Implications of Counternarratives A and B

The counternarrative of Katrina suggests policy and practice implications to the authors, stakeholders in the computer science department at the target university. We need to strengthen the pathways between 2 year and 4-year programs in CS. A review of departmental and institutional communications conducted by the authors indicate lack of clarity regarding transfer, particularly from systems outside of the state system. The departmental website has no information about transfer pathways, and the financial aid support pages have few working links and many crossed off scholarship opportunities. The institutional communication of transfer policies and costs are more clear for entering students, yet the categorization of out-of-state tuition support as "scholarships" rather than aid may dissuade students with less positive academic records for applying. Many Hispanic students start at community colleges and then consider transferring to a 4-year university to complete a Bachelor's degree, but many students discontinue their education with the Associate's degree because they do not see the need to continue to a Bachelor if they can get a good-paying job with an Associate's degree. State to state mobility is not communicated at the departmental level, yet communities in the rural southwest cross state lines, making tuition policies salient to computer science students across borders. Once community college transfer students reach a 4-year, many of them share Katrina's experience, where they feel like they don't belong at the 4-year, because they don't have the same shared experiences as the non-transfer 4-year students. Faculty need to hear about Katrina's experience with the 'closed' door policy, as those incidences were made worse by the COVID pandemic but are still happening post-covid. University faculty's first job should be teaching and understanding where students are coming from, but especially at the university, with the focus on becoming an R1 institution, there is an increased focus on research and grant writing. This shift in faculty focus is evident in the student experience.

The counternarrative of Ernesto suggests policy and practice implications to the authors as well. Ernesto's story brings out how the feeling of belonging is elusive for students, even when representation of ethnicity and culture is present. Ernesto described initial faculty engagement with later experiences with faculty being less positive—faculty indicated they would not be able to support learning outside of the scheduled course time. Like his peers, Ernesto found other support systems, including staff members in the department. Ernesto's views regarding diversity through language learning and immigration in the department could be better messaged, and utilized as a sense of common purpose and community building, yet to date these similarities are not acknowledged. While Ernesto was a first-generation student in the United States, his family member was able to support him with disciplinary knowledge and serves as a mentor within the field, an uncommon asset for first generation college students at the university. We note that, for those naturalizing to the country from nearby communities across borders, age of naturalization can come late in the BS degree, at a time when most similarly educated citizens have

experienced internships and other job preparation supportive of long-term success in computer science. Departmental action could support student career trajectories.

Implications of this work: Opportunities to Increase Inclusion in CS at UNIVERSITY

Counternarratives are developed to share multiple truths, and to work as tools for social justice. As stakeholders of the university computer science department, we hope to receive feedback on the ways in which the department might engage with counter storytelling. As a collaborative, our next steps are to develop an action plan that gives voice to counternarratives and brings truths about student experiences to the forefront of departmental decision making and climate work. In this way, we will create social justice action from the applied research effort we report at ASEE. Some possible mechanisms for creating dialog with faculty in computing at the university include a) sharing current counternarratives with faculty with opportunity for discussion in a faculty meeting, b) proposing communications changes to departmental staff and leadership to clarify opportunities in the CS department, and c) developing student climate survey instruments that relate to concerns demonstrated in counternarratives. We recognize issues of power, privilege, and elitism will be salient in discussions that fight against hegemonic scripts of who is right for computer science, and honor the notion that students can and should voice their own stories when they are empowered to do so without fear of unintended consequences.

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