The Role of Validation for Latino/a and Low-Income Transfer Students in Engineering and Computer Science Fields

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Structured Abstract

Background: Attempting to counter the lack of diversity in the current STEM workforce, institutions of higher education have enhanced student support programs and expanded undergraduate research experiences for underrepresented students. We are just beginning to understand the theoretical and actual processes that take place in these contexts.

Purpose/Hypothesis: In addressing this gap in knowledge, we describe the experiences of two underrepresented groups, Latino/a and low-income students, in undergraduate engineering and computer science fields in one of these programs. We frame these experiences in terms of validation theory.

Design/Method: We conducted a case study of a student support program for underrepresented students in engineering and computer science fields at a large public university in the Western United States. We interviewed 24 students about their experiences with the resources that the program provided them and analyzed data using thematic data analysis.

Results: The accounts from the participants revealed three general findings: (1) faculty guidance and close peer relationships aided students in navigating complex and intensive academic systems; (2) student-faculty interaction, practical experiences, and immersion in a relatable group of peers led to a sense of belonging and self-confidence in students; and (3) familial support affirmed students' goal of degree completion.

Conclusions: Validation theory provides a useful framework to understanding how faculty members, peers, and family members contribute to the academic and personal growth of students by legitimizing their presence in the college environment. Administrators should attempt to

incorporate validating experiences in student support programs for underrepresented students in engineering and computer science fields.

Introduction

The job market in STEM—science, technology, engineering, and math—fields faces two industry-level problems. The first problem relates to the claim that the market lacks enough well-trained candidates to fill the growing number of available jobs in STEM. According to the Bureau of Labor Statistics (U.S. Department of Labor, 2014), the United States is expected to add to its economy more than 9 million jobs in occupations related to STEM between 2012 and 2022. This would mark an increase of 1 million jobs, or 13 percent, above the 2012 total. Yet some economic projections indicate that the U.S. will fall short of 1 million STEM professionals needed to maintain the country's command in the industry if the current rate of entrants to the industry holds over the next decade (Olson & Riordan, 2012). In order to sustain American innovation, economic output, and global competitiveness, American colleges and universities would need to increase its yearly production rate of STEM degrees by 34 percent (Olson & Riordan).

The second problem is less complex: Latino/as and blacks are simply underrepresented in the STEM workforce. According to a report on the 2011 U.S. Census Bureau American Community Survey (Landivar, 2013), non-Hispanic whites comprised 67 percent of the total workforce, but held 71 percent of STEM jobs. Similarly, while Asians held 6 percent of all jobs, they were employed in 15 percent of STEM jobs. In contrast, 10.8 percent of blacks or African Americans held jobs in the total workforce compared to 6.4 percent of STEM jobs; for Hispanics and Latino/as, the disparity becomes even more pronounced with further investigation. These two groups comprise nearly 15 percent of the total workforce but only represent about 6 percent of all STEM workers.

This phenomenon leads to a much larger problem: the accessibility of obtaining a college degree. Since most STEM occupations require at least a bachelor's degree, the fact that underrepresented students of color graduate from STEM fields at lower rates in comparison to their peers poses a critical problem. Previous research has shown that Latino/a students are less likely than white students to earn a degree or certificate in a STEM field (Chen & Weko, 2009). A report by the Institute for Higher Education Policy (Cullinane, 2010) showed that 16 percent of Latino/a students who began college as STEM majors in 2004 completed their degree in a STEM field by 2009, compared to 25 percent of white students. Low-income students are another underrepresented group in STEM education, and they tend struggle on their path to earning a STEM degree. Using longitudinal data, the National Center for Education Statistics (Chen, 2013) found that low-income students in STEM majors were more likely than their high-income counterparts to change majors or quit college entirely before earning a degree.

While there has been significant research related to the educational pipeline of students of color in STEM degree programs, it has been narrow in scope. Rich, descriptive accounts on the experiences of members of these two groups—Latino/a and low-income students in STEM fields—are lacking in the higher education literature. As government and industry sectors respectively and collaboratively seek to increase both the overall number of STEM workers and the diversity of the STEM workforce, studies on student support programs have offered insight into high-impact practices for retention and degree completion in STEM fields (Hurtado, Cabrera, Lin, Arellano, & Espinoza, 2009; Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012; Wilson et al., 2012). Yet such studies have not illuminated the mechanisms behind the interpersonal relationships that help underrepresented students succeed. For example, within a STEM student support program, there is little about *who* the agents of change that participate in a student's academic and personal development are, *what* contexts structure these processes, *what* student changes that take place, and *why* these changes enhance STEM degree completion and entrance into the STEM workforce. Simply put, current scholarship lacks an applicable theory or explanatory framework to understand their experiences from a qualitative perspective.

In this study, we report the results of our interviews with Latino/a and low-income college students in two STEM fields, engineering and computer science, as they participate in a student support program. Their stories relate patterned, yet nuanced, interactions with professors, peers, and family members that underscore the importance of support and mentorship for nontraditional students in engineering and computer science degree programs. Framing our study within Rendón's (1994, 2011) validation theory, the aim is to develop an understanding on how historically underrepresented students, such as low-income and first-generation students, find success in college. The interview data in our study align with the general principles of validation theory and provide interpretive insight into the particular ways in which validation influences underrepresented students in engineering and computer science. By mapping the study results to a theory of student development, we move closer to a systematic understanding of how underrepresented students succeed in engineering and computer science fields. We thus offer the overall conclusion that for Latino/a and low-income students in engineering and computer science majors to excel academically and grow intellectually, they should participate in student support programs that promotes a community of learners with validating experiences.

In the next section, we provide an overview of the literature relates to underserved and transfer students in STEM majors, with special attention to student-faculty interaction, peer-peer interaction, undergraduate research experience, and family support. We follow this review with details on the study sample, methods employed, and an analysis of the qualitative interviews. We conclude with a discussion of the findings as they relate to validation theory and study implications.

Literature Review

The following literature review focuses on three dimensions of academic success for underrepresented students in STEM fields: student-faculty interaction, peer-peer interaction, and familial roles. We then present descriptive accounts of student support programs for underrepresented students in STEM degree programs. Lastly, we discuss the conceptual background and past empirical work related to validation theory.

Undergraduate Student-Faculty and Peer-Peer Interaction in STEM Fields

A longstanding scholarly line of inquiry exists linking positive outcomes to the extent and quality of student-faculty interaction (Pascarella, 1980) and peer-peer interaction (Astin, 1984) in the college environment. In this section, we point to these general patterns in STEM fields and then relate them to Latino/a and low-income students.

General patterns of student-faculty and peer-peer interaction in STEM fields. Generally speaking, more frequent student course- and non-course-related contact with faculty is associated with a host of college student outcomes including: continued student learning, intellectual growth, cognitive development, career aspirations, attitudinal changes (Pascarella & Terenzini, 2005; Pascarella, 1980), scholarly self-confidence, leadership ability, and degree aspiration (Pascarella & Terenzini; Sax, Bryant, & Harper, 2005; Kezar & Moriarty, 2000; Astin, 1993). In STEM programs, the connection students have with their faculty members has been shown to play a pivotal role in how students navigate undergraduate STEM careers. In fact, faculty members' approachability and teaching style can affect students' perceived ability and performance in the classroom (Vogt, Hocevar, & Hagedorn, 2007). Using a large sample of engineering students at four research universities, Vogt (2008) found that students had greater engagement with the course materials when they held a positive attitude toward their instructor and classroom environment. Indeed, faculty members can structure classroom environments by having the ability to create a "warm" and encouraging or, in contrast, a "cool" and defeating environment. Naturally, the classroom environment can differ by discipline. For example, Serex (1997) found that both males and females in education and nursing programs felt that their classes had a "warm" atmosphere. In contrast, both genders perceived their engineering classes to be "cooler" (p. 76)

The frequency and quality of instructor feedback may also be related to development of marketable skills in the workforce and professional goals. In fact, the most frequent contact between students and faculty is course-related contact inside or outside the classroom (Kuh and Hu, 2001)—so frequent and substantive feedback in any context is meaningful. In a study of more than 1,500 students across several campuses enrolled in a first-year engineering course, Bjorklund, Parente, and Sathianathan (2004) reported positive associations between instructor feedback and both self-reported gains in problem solving skills and engineering competence. Additionally, faculty can provide students with direct and meaningful feedback through mentoring. In fact, students in STEM degree programs who receive faculty mentorship show greater likelihood of college persistence over those who do not (Didion, 1996; Packard, 2004).

Higher education scholars have also pointed to interaction among peers in STEM fields as a factor in determining a student's academic integration and success. Much of this scholarship places an emphasis on collaborative learning—a key area of study given that collaboration is pervasive in and vital to the industry. A meta-analysis by Springer, Stanne, and Donovan (1999) demonstrated that within STEM courses small group collaboration promoted student achievement, persistence, and attitudes toward learning. Even so, disciplines such as engineering face barriers to collaborative learning, including competitive classroom environments (Seymour & Hewitt, 1997; Guzdial et al., 2001). In some settings, proficient students may become possessive of their skills and avoid helping their peers (Seymour & Hewitt, 1997; Guzdial et al., 2001), which discourages more constructive and collaborative peer-peer interaction. Other barriers to collaboration present themselves when students of lower ability become reluctant to ask for help lest they appear incompetent (Seymour & Hewitt, 1997).

Latino/a and low-income student contact with STEM faculty. While faculty-student interaction and peer-peer interaction generally supports student development in college, contact between faculty and students of color benefits students benefits student development. Specifically, faculty contact with underrepresented students is linked with higher grades and degree completion (Kim & Sax, 2009; Cole, 2010). However, the strength of the effects differs by student group and the form the interaction takes. For example, low-income and students of color are less likely to interact with their faculty members than others (Astin, 1993; Terenzini, Cabrera, & Bernal, 2001). Cole (2007) reported group-level differences in the amount of course-related faculty contact and advice and criticism from faculty among black, Asian, and Latino/a students. Further, the advice and criticism from faculty negatively impacted the mean GPA for each group.

Because faculty generally shape institutional contexts, particularly faculty practices and characteristics, they play a role in shaping the experiences of underrepresented students in STEM fields. Indeed, prior research has demonstrated that underrepresented students' perceptions of the campus racial climate are based in part on their interactions with faculty (Hurtado, 1994). In a large sample of "aspiring scientists," Hurtado et al. (2011) found that for black students, attending a historically black college or university increased their chances of interacting with faculty. However, this same type of relationship did not hold for Latino/a students attending a Hispanic-serving institution (HSI), which is in line with an earlier study finding no difference in the experiences Latino/a students had with faculty at HSIs and predominantly white institutions (Nelson Laird, Bridges, Morelon-Quanioo, Williams, & Holmes, 2007). These studies point to the idea that the *choices of faculty members* (in their advising practices, teaching styles, mentorship roles, and feedback given) have greater bearing on student perceptions of faculty over the simple racial and ethnic makeup of the campus population, at least for Latino/a students.

Experiences of Latino/a and low-income students in STEM peer environments. For underrepresented students in STEM, such as Latino/a and low-income students, supportive peer environments can have a substantial impact on one's academic progress. Co-curricular involvement provides such a context, where Latino/as and student of lower socioeconomic backgrounds can foster a caring educational community (Hernandez 2000; Hernandez & Lopez, 2004). Moreover, for students in STEM fields who lack college-educated parents, findings from Cole and Espinoza (2008) suggest that peers provide sources of knowledge for improving academic outcomes.

Such peer networks are essential in competitive science environments, which may contain stereotyping and social stigma of groups from communities of color (Treisman, 1985; Fries-Britt 1998). Depending on context, peers can foster either stress or motivation for students. When these communities of learner are established on a premise of collaboration instead of competition, , students can inspire one another to excel in their academic performance and provide motivation to think of innovative ways to problem solve perform better academically (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009).

Familial Roles in the Academic and Social Lives of Latino/a and Low-Income Students in STEM Fields

For many students, the family is the main foundation for their decision-making processes and their social choices. Indeed, families of color tend to emphasize the importance of academic success and healthy social lives. The families of underrepresented students in STEM fields function in several ways. For one, students from this population may enter into STEM primarily to help their families financially (Seymour & Hewitt, 2008; Trenor, Yu, Waight, Zerda, & Sha, 2008). Similarly, Phinney, Dennis, and Osorio (2006) point to an interdependence between college students of color and their families that is distinct from white students and their families. Specifically, Latino/a parents of engineering students may stress the importance of completing a degree more than venturing into a specific profession (Trenor et al., 2008). On this point, Trenor et al. found that parents of Latino/a respondents typically did not have a STEM background, nor did they particularly appreciate the content of what their children were studying.

Latino/a families are often limited in the cultural capital that they can pass down to their children who are entering STEM fields. This can affects the student's' ability to gather basic information about financial aid and choosing colleges (Martin, Simmons, & Yu, 2013). Trenor et al. (2008) reported that Latino students had significantly fewer generations of their families with college education compared to their black and white counterparts; the same group differences were evident in the highest level of education attained by one or more of the student's parents. Whereas white students identified with "carrying on a family tradition in college" (p. 456) and viewed their family members as role models, Latino/a students described their entrance into STEM as a means of helping their families (rather than vice versa).

Undergraduate STEM Support and Research Programs

Engineering and computer science support programs for underrepresented students, particularly those designed for transfer students of color who participate in faculty research, have increased in recent years amid the emphasis on STEM education in both academic and commercial sectors. Such programs typically provide low-income students and students of color with a combination of tuition support, faculty mentorship, tutoring, peer support groups, and research opportunities. This last feature has gained special attention due to studies supporting its efficacy. Here, undergraduate research experiences have been shown to increase persistence and affirm decisions to enter into STEM careers (Lopatto, 2007; Russell, Hancock, & McCullough, 2007; see Olson & Riordan, 2012). In the Lopatto (2007) study, students from underrepresented groups demonstrated greater learning gains than their counterparts. Further, for support programs containing a research component, Hurtado et al. (2009) reported that underrepresented students experienced science as an "empowering" enterprise, and in turn exhibited high self-efficacy and identification with science.

Validation Theory

Prior research has demonstrated that students from low-income and Latino/a backgrounds benefit from validating experiences in their academic pursuits (Rendón 1994; Nora 2003). For Rendón (2006), validation differs from popular notions of "student involvement" in that the latter term refers to students taking the initiative to participate in campus activities. Validation theory, rather, envisions faculty members and campus administrators initially engaging with underrepresented students who find it difficult to get involved, have been discouraged in their educational pursuits in the past, and have doubts about their abilities to succeed.

Conceptual background and empirical work using validation theory. Rendón (1994) developed validation theory based on data from interviews with 132 undergraduates in four different institutional settings. She found that when individuals such as faculty, staff, and family members took the initiative to validate students academically and as individuals, students believed they could be successful in college. Her interviews also revealed that nontraditional students (first-generation, low-income, and mostly from racial/ethnic backgrounds historically underrepresented in higher education) tended to arrive on campuses without the confidence and institutional knowledge that traditional students (middle-class, with college-educated parents, and mostly white) possessed. To navigate institutional life on campus, many nontraditional students depended on active intervention—in the form of validation—from significant in- and out-of-class individuals (or "agents").

Validation theory focuses on the student as a whole human being and attempts to account for both their academic and personal development (Rendón Linares & Muñoz, 2011). As an explanatory model, validation theory presents six elements: (1) Institutional agents such as faculty, advisers, coaches, lab assistants, and counselors are responsible for initiating contact with students; (2) When validation is present, students feel capable of learning and have a sense of self-worth; (3) Validation can be viewed as a prerequisite for student development; (4) Validation can occur in and out of the classroom; (5) Validation should not be viewed as an end, but rather as a developmental process which begins early and can continue over time; and (6) Validation is most critical when administered early in the college experience, especially during the first few weeks of class and the first year of college (Rendón Linares & Muñoz).

Researchers have applied the theory in multiple ways with several populations in recent years. Examples include work on cultural identities and persistence of Latino/a undergraduates (Gloria, Castellanos, Lopez, & Rosales, 2005); the development of Latino students' self-concept (Hernandez & Lopez, 2004); transfer students from a community college to a university (Suarez, 2003); and Native American high school students (Nora, Urick, & Quijada Cerecer, 2011).

Research Problem and Contribution to the Literature

Bolstered by empirical research and program evaluation studies, academic, government, and nonprofit stakeholders appear to have reached an understanding that structured support programs are beneficial for underrepresented students in STEM fields (Lopatto, 2007; Russell, Hancock, & McCullough, 2007; Hurtado et al. 2009; Olson & Riordan, 2012). However, such studies have not explored key individuals and specific situations that validate Latino/a and low-income transfer students in engineering and computer science fields. In this study, we employ scheduled interviewing and frequent examination of the data to uncover the mechanisms and overarching explanatory model that applies to this population. In doing so, we are the first to apply validation theory to (1) a student support program designed for low-income and Latino/a transfer students and (2) a sample exclusively of undergraduate students in engineering and computer science fields.

Research Questions

The current literature and an effort to understand how Latino/a and low-income students in engineering and computer science majors experience a student support program inform our research questions. Specifically, for students from these groups, we ask how does validation from in- and out-of-class agents, including faculty members, peers, and family members *help us understand their development* as college students and *frame their success strategies in college?*

Methodology

We employed a case study design. Although case studies are often thought of as a study with a sample size of one, this, in fact, describes only a *type* of case study. A case study is better defined as "an in-depth description and analysis of a bounded system," which can be a person, program, group, community, specific policy, or an institution (Merriam, 2009, p. 40). Case studies are intended to glean information about a larger phenomenon. In this instance, our case was a student support program for underrepresented engineering and computer science majors, which we've given the pseudonym "Connect" for this study. We studied Connect in order to uncover the significant processes that were illustrative of student support programs for underrepresented students in STEM, i.e., the phenomenon. In order to do so, we drew a sample from the population of students enlisted in the program. Here, we were motivated by our discovery and interpretation of the experiences that were frequent and meaningful for students in the program.

Our case study can be said to be of the "heuristic" type as it intends to "illuminate the reader's understanding of the phenomenon under study" (Merriam, 2009, p. 44). For Stake (1981), such studies might reveal "[p]reviously unknown relationships…leading to a rethinking of the phenomenon being studied" (p. 44). Indeed, previous studies have related measured, quantified outcomes of student support program in STEM fields (Maton, Hrabowski, & Schmitt, 2000; Wilson, 2012), yet they have not reported the complex actions and attitudes of the students in them. Our findings suggest that validation theory helps frame these particular actions and attitudes.

Research Setting, Sampling, and Recruitment. Our study sample was comprised of undergraduate transfer students from Connect, a student support program for underrepresented engineering and computer science majors at a large, public university in Southern California, given the pseudonym here of Southern California University, or SCU. Designated a Hispanic-Serving Institution (HIS) and Asian American Native American Pacific Islander Serving Institution (AANAPISI), SCU serves a diverse student body in a bustling urban region. Housed in a college that serves engineering and computer science students, Connect was established with funding from the U.S. Department of Education with the broad intent to help Latino/a and low-income students transfer from local community colleges to a four-year university (research site) where they would then graduate with degrees in engineering and computer science. The specific goals included: (1) increase the number of Latino/a and low-income transfer students from local community colleges into degree programs in engineering and computer science at the research site; (2) increase the graduation rate of these two student populations in engineering and computer science at the research site; and (3) develop a feasible model for the transfer of these students into the aforementioned degree programs.

The students selected for Connect are placed in a cohort designated by the year in which they transferred to the research site and into Connect (i.e., Cohort 1 for the first year of the program and Cohort 4 for the fourth year) and major department [Civil Engineering and Construction Management (CECM), Mechanical Engineering (ME), Manufacturing Systems Engineering and Management (MSEM), Electrical and Computer Engineering (ECE), and Computer Science and Computer Information Technology (CSCIT)]. The program provides the Connect students with tuition support (as a stipend); tutoring for preparatory math and science courses; advisement by program administrators; faculty and peer mentoring; opportunities to attain internships at local companies; and opportunities to participate in hands-on lab and research projects with their faculty mentors.

We used stratified purposeful sampling to gather a sample of Connect students to interview. In this fashion, we attempted to include in our study Connect students from each cohort (1, 2, 3, and 4) and major. We sent an email to all Connect students inviting them to participate in the study. We also asked their faculty mentors to encourage them to participate. Of the final sample of 24 study participants, 19 (79 percent) were male and 5 (21 percent) were female. In terms of undergraduate major, 8 (33 percent) were in mechanical engineering, 7 (29 percent) in computer science and computer information technology, 5 (21 percent) in electrical and computer engineering, 3 (13 percent) in civil engineering and construction management, and 1 (4 percent) in manufacturing systems engineering and management.

Data Collection and Analysis. Under supervision of the lead researcher, a team of three researchers conducted interviews with the study participants during the summer and fall of 2014. The interviews, which were recorded, lasted between 45 minutes and two hours. Participants learned of the interview's voluntary nature and asked to sign a consent form per the Institutional Review Board protocol before beginning. After transcribing the interviews, the researchers deleted the digitally recorded audio files.

In creating the interview protocol, we referred to past studies on Latino/a and low-income students, validation theory, and access to resources conceptualized as financial, human, social, and cultural capitals (Bourdieu, 1986). We sought responses in an attempt to understand *what happened* when students were granted resources to assist their educational, professional, and personal development. Prior research has established that forms of capital can explain the differential outcomes of college students by racial/ethnic group (Massey, Charles, Lundy, & Fischer, 2011). Yet studies of capital rarely delineate the *processes* that occur when students are granted the opportunities to achieve. What *experiences* do *forms of capital* engender? In our view, the experiences might be validating ones, and we turned to Rendón's (1994) theory in developing our questions to ask of underrepresented students in engineering and computer science majors. To illustrate, we asked questions such as: "Do you think you need encouragement from others before you get involved in an activity, organization, project, or research opportunity here on campus? Why is that?" Also, "How do your faculty members make you feel as a student? What is the sense you get from your family members?" Such questions elicited specific details about who was *involved*, what was *said*, what was *done*, and what was *changed* in the student. Indeed, resources are capable of increasing the academic success of underrepresented students in STEM (Cole & Espinoza, 2008; Martin, Simmons, & Yu, 2013) but vivid responses from the mouths of the students reveal *how* this is so.

We analyzed the interviews in ATLAS.ti, a qualitative data analysis software program that was able to code the transcriptions into significant themes. In an attempt to increase reliability, the lead researcher and two researchers participated in the analysis. This inter-rater strategy, termed "multiple coding," encourages researchers to face competing explanations and to generate insights about the data at hand (Barbour, 2001). In our study, each researcher created codes, links between and among the codes, and eventually identified a set of preliminary patterns within the data. After doing so, they compared their rough themes. Both researches felt that validation theory framed the personal and academic growth students related in their comments about mentorship, practical experience, and encouragement. Although the themes noted by each researcher differed in their precise wording, they shared a degree of overlap that fit within three broader, structured contexts. Lastly, quotes that contradicted the patterns were identified.

Results

In analyzing the transcripts of the 24 interviews, we identified three major themes. As the students described what Connect program experiences meant to them, we noted their personal and academic growth. Generally, specific on- and off-campus agents offering practical and affirming guidance, opportunities, and compliments exemplified their time in the support program.

Theme 1: Ability to Navigate New and Complex Academic and Professional Systems

An element of the Connect program consists of helping underrepresented transfer students in their *transition* from a community college to a large university. In transferring, students must navigate a new geographical landscape (campus), department (engineering or computer science program), and social terrain (interactions with administrators, faculty members, and peers). More daunting for some students is the realization that their transfer-receiving institution (university) is not the final destination, but rather an essential checkpoint through which they must pass before entering an industry with an entirely different set of social and technical systems.

Through the Connect program, students can generally access key on-campus agents that assist in the process going from discovery, to competence, and finally to confidence with regard to academic structures. Specifically, students must figure out which classes to take and when; understand the course material to a satisfactory degree so that they succeed in subsequent courses and meet normative benchmarks for internships and research opportunities in engineering and/or computer science fields; and if they struggle with course material, possess the foresight and humility to seek and complete tutoring.

Once enrolled at the university, Connect students attend weekly meetings with a faculty mentor and fellow Connect students from their major department. In these meetings, faculty mentors—of whom some are department chairs—provide recommendations to students about program requirements and resources—as sort of group academic advising sessions. According to one male participant in electrical and computer engineering:

> I feel like being part of Connect and just having someone checking on you to see if you're passing your classes, willing to help you out with anything, has definitely pushed me to keep trying harder with my classes. I've just been getting a lot of support from Connect and now that I'm working with one of the professors, I talk with them more often so I feel like Connect has been part of my success so far here.

While participants could gather formal information on requirements from faculty members, from their peer mentors they frequently became privy to informal information, including opinions on the teaching styles and personalities of instructors and utility of certain courses. Since the peer mentors are Connect students themselves who are further along in their respective programs, less-advanced Connect students often reported feeling more comfortable in these peer-mentoring relationships. For example, one male, mechanical engineering student reported: "Whenever I had a problem, I went to [my peer mentor] and she was very helpful. She helped me a lot in many ways. So anything I had a problem with, she emailed me or called me or whatever and just resolved the problem."

Similarly, in speaking about his peer mentors, a male student in computer science and computer information technology expressed:

> They were just very open-minded and what was really good about them, too, was that they knew the subject matter very well and they found a way to help

> you and include you in the program and help you get used to it—even though sometimes we were talking about subjects that are pretty difficult or trying to get a hold of, instead of them just dismissing us or just not covering everything, they would kind of promote it and want us to be part of that.

Here, the student expresses appreciation for the mentors' willingness to spend time explaining difficult subjects. The peer mentors represent a vital set of institutional agents for underrepresented transfer students in programs like Connect. Not only are the mentors from similar socioeconomic backgrounds, cultural groups, and communities, but they are also *transfer students* with first-hand knowledge of the technical and social systems that the newer Connect transfer students must navigate. Indeed, the mentors' unique status as transfer students and institutional agents tend to position them to guide newer Connect students in their transitions from community college to university settings. For some students, this dynamic can be seen in their feelings of intimidation when talking to faculty members, for fear of taking up their time or "sounding stupid." On this point, in speaking about his professors, one male student in civil engineering and construction management said, "There's a barrier you can't cross. You can ask them [questions] but can't really get comfortable and talk as if you were talking to your friend or the tutors." Similar to the latter, the mentors were said to consistently create a nonthreatening environment where students could seek answers that had instrumental value for their academic journeys.

In addition to the peer mentoring, students also generally received essential information about bureaucratic processes from administrative staff and tutoring from fellow students for "gateway classes," i.e., those classes students must complete before advancing to electives and upper division courses. These combined efforts kept students attuned to programmatic requirements, especially when they were most vulnerable, as in their first semester. For example, one electrical and computer engineering student, who is also a veteran, said, “If I wasn’t in the Connect program, then I probably would have floundered a little bit more. But since I had that support group, they were able to tell me what I needed to do.”

Throughout the interview process, we discovered an emphasis that students put on treating their college education as a direct pathway to a career in their engineering or computer science field. Through Connect, students seemed to come to understand the fact that college was not only a time to become associated with course content, but a mechanism by which they could obtain letters of recommendation, professional-quality résumés, internships, and real-life research experience as well. In their weekly meetings, faculty mentors stressed the importance of extracurricular activities in landing a job after college. Similarly, cohort members, tutors, and members associated with Connect shared information with one another about internships, jobs, and clubs and associations that offered workshops for future job-seekers in STEM. Looking back on her time in Connect, one student from the first cohort noted:

> “I already asked a couple of them for recommendations, scholarships, jobs—to be a reference. It’s good to know someone and to have a good connection with them so if you really need a reference you can contact them and they will be able to provide that to you” (Female, CSCIT).

Consistently, students cited networking in college as imperative to professional success. Indeed, *who* one knows matters to all potential job applicants, but these networks are especially meaningful for underrepresented transfer students who may have entered a four-year institution unaware of their need to make career connections. One male MSE major, who had clearly come to understand the prescribed custom of getting to know one’s peers, said: “More networking is going to make it easier to get a job. So if you get into Connect, you're more connected to people so you can network more in Connect than if you're just [taking classes at SCU]." Further, students realized that not only faculty members, but *one another*, could form a tie that eventually leads to a job. Speaking to this, one male CSIT student and former Connect mentor said: "We've already [in] that kind of stuff, like LinkedIn connections and Facebook friends…So we've kept in contact outside of SCU."

What we see here is the meaning that interactions with faculty and peers tend to have in acquainting underrepresented students with institutional processes that lead to academic success and career development. When such interactions are structured—through weekly meetings with faculty mentors, convenient access to program advisors, and regular contact with peers in the same program—students learn to navigate complex technical and social systems that are often daunting at first. This pattern requires constructive, proactive involvement on the part of institutional agents following guidelines built into Connect. Since historically underrepresented students work off campus, hold family wellbeing as their top priority, and are reluctant to ask questions of superiors, they may miss out on tutoring, advisement, office hours, and club meetings—all of the ingredients of students success in college. When influential agents take responsibility for initiating contact (rather than waiting for underrepresented students to come to them with prepared, tactical questions), the students have a better chance at taking advantage of opportunities and the academic and professional competence that they afford.

Theme 2: Development of Self-Confidence and Sense of Belonging

A growing interest in the higher education literature concerns non-cognitive traits that students develop in college. Validation is certainly an example, but tied to this broader concept are one's sense of belonging and self-confidence, which are plausible byproducts of validating experiences.

Sense of belonging, originally intended to measure one’s perceived social cohesion within a university, city, or country (Bollen & Hoyle, 1990), has since been applied to how comfortable, respected, and acknowledged Latino/a students feel on college campuses (Hurtado & Carter, 1997). Self-confidence—in academic settings, specifically—refers to “a confidence in one’s academic and intellectual abilities in general as well as confidence in particular aspects of that ability (e.g., mathematical ability or skill in problem solving)” (Laird, 2005, p. 367).

In our discussions with underrepresented students in STEM fields, a common theme of connection was noted. Student felt connected to their respective programs, by stating that they were “in the right place.” Further, students frequently expressed a facility with course material, networking, joining clubs and associations, and impressing others in their work as researchers, interns, or entry-level employees. To be sure, a few students cited difficulties and insecurities, but all felt capable of overcoming them if they just put in more effort, restructured their schedules, or made any number of changes addressing issues other than intellectual or cognitive skills. When we sought details about the circumstances that engendered a sense of belonging and self-confidence, students related validating experiences with faculty members, practical research experience, and inclusion in a group of similar peers. We discuss these elements below.

A main feature of the Connect program is the weekly meetings students have with their assigned faculty mentor. The meetings are designed so that the mentors can give their mentees essential but not explicit curricular information pertaining to their major and guidance on research projects and professional development. (We detailed this knowledge transfer in Theme 1.) For our interview participants, the meetings also seemed to act as a space for professors to compliment students, share personal experiences, and give substantive advice, all of which helped students feel valued and respected.

One way in which faculty mentors tended to promote confidence in their students was by having students design challenging projects. As one male participant in CSCIT noted:

> We pretty much come up with projects we want to work on every semester and because [my faculty mentor] gives us the freedom to pick the project that we want to work on, no matter how difficult it might seem, or the scope of it might not be achievable for our grade level or whatever, she still goes ahead and gives us confidence. When we get to points where we might be stuck or we might need help she'll bring in either former students or people in the field to give us a little bit of help on where to go from there. And because she gives us so much freedom I think that's where we just get the confidence.

For Rendón, Linares, and Muñoz (2011), faculty members can "validate students as creators of knowledge and as valuable members of the college learning community" (p. 12). In the quote above, one of the projects to which the participant was referring was meant to showcase work from students across engineering and computer science majors at SCU. The student's faculty mentor quite literally asked him to be a contributing member of his college community, and, according to the participant, the creative freedom translated into a general confidence in his ability as a student.

In certain cases, Connect faculty mentors generally welcomed students and explicitly supported feeling of belonging at the university, sometimes in compelling ways. For example, a couple of faculty mentors self-disclosed information, ranging from the good to the bad, about their careers in engineering and computer science. One male, mechanical engineering participant said:

> I spoke to him for a while, midway through last semester after he…got laid off from his other job. So, we connected on a bit of a personal level there where we had a chance to discuss work in general and you know, the approaches to work and enjoyment, because he has been teaching the whole time; he's been working ever since he graduated. So, you know, he enjoyed his work but he enjoyed his teaching more so he really wasn't torn up about being laid off because he still had something that he really enjoyed doing. So it was an interesting conversation to say the least .

As we have mentioned, nontraditional students often feel uncomfortable asking questions of faculty members or confronting them with personal issues for fear of being viewed as unsuited for higher education. When faculty members appear disarming, students might perceive this an invitation to disclose their own experiences in engineering or computer science classes or outside of class on campus. For our purposes, such interpersonal validation affirms underrepresented individuals as *persons* as well as students. In refusing to detach themselves from their students, faculty members become an accessible participant in their students' learning, rather than an aloof, detached authority figure.

The seemingly simple act or faculty mentors complimenting students cannot be overstated. From students' perspectives, the experiences with professors and instructors that participants found meaningful most frequently included ones where participants received praise and encouragement. According to one of our participants, a male student in ECE:

> I feel like when I get positive feedback, [I] definitely worked even harder to continue to do well and continue to work towards positive feedback. You feel a lot better when you get positive feedback than when you get negative feedback.

> So I do feel like being validated has helped me continue to work harder in my classes and eventually graduate from here.

Other participants added: “He supported me emotionally and educationally” (male, ME), “[H]e would always say ‘good job.’ Just those two words…that’s all I needed” (another male, ME), and “I feel like I belonged here the first time that I spoke to the mentor and the department chair. They’re really friendly” (male, MSEM). Expressions of kindness and interest from agents in positions of authority (faculty members and department chairs, in this case) tend to validate students on both personal and academic levels. In these conditions, students can bond to a specific faculty member not just because an academic confers status but also because key institutional agents respond to students’ emotional and social needs.

The relationships that participants formed with their faculty mentors, peer mentors, and peer tutors also seemed to foster opportunities for extracurricular activities such as research assistantships, internships, and positions in clubs and associations. If students shared concerns on whether or not they belonged in their respective departments or at the university, these experiences seemed to mitigate their doubts. In their comments, some participants expressed that the provisions of lab resources and access to key authority figures were key indicators that SCU wanted underrepresented students its engineering and computer science departments. Additionally, they spoke of internships and research positions as experiences they “needed” to fulfill their primary goals: graduate and find a job in STEM. By securing these positions, they became more confident in doing so. As one student, a female in CECM, put it:

> For the summer, I interned with a general contractor and a construction management company…. I grasped a lot and I made connections pretty well

> [to the class material]. So that helped me a lot too. Mostly, it boosted my confidence in my future career.

Connect provides its students with early announcements about research assistantships and internships both on and off campus. Though Connect students are by no means guaranteed a position, the fact that faculty mentors reach out to and recruit select students with this information demonstrates their proactive role in promoting academic and career development—and broader outcomes like retention and completion—among underrepresented transfer students. For students, such gestures imply that institutions of higher education understand that underrepresented students may need extra support to boost confidence and increase awareness to search for and apply to these positions. Our results suggest that when underrepresented transfer students *are shown and encouraged* to interview for these extracurricular activities, they will.

Immersion in a relatable, reliable, and supportive group of faculty and scholars was another mechanism that seemed to facilitate a sense of belonging among study participants. The diversity of students in terms of both race/ethnicity and perceived socioeconomic background integrated rather than isolated the Connect students in their respective departments. On this point, one male, ECE participant shared:

> Most of us are the first generation so a lot of our parents came from Mexico and most of our parents have two or three jobs in order to support us. We don't have someone in our family who's already graduated who can guide us or tell us the steps on going from high school to a university. I really identify myself with other Latinos because it's going to be a great thing once we graduate. [S]ome of my friends have become gangsters, but some of the people that I know now have been able to choose a different path and now they are going to

> become engineers. Just I feel like we feel more confident when there's people with similar backgrounds as you. And then when we help each other out, it's just great.

Here, this male ECE student program brings individuals together from similar backgrounds and demonstrates to the student a sense of community. Peer networks in college are useful in multiple ways. They are a means of: (1) intellectual support when encountering difficult homework problems and preparing for examinations; (2) professional support when students are in the market for internships and jobs; and (3) emotional support in times of both duress and joy. In the Connect program context, when used simultaneously, these tools can maximize their effectiveness within a group of individuals from similar backgrounds. To this point, one male CSCIT student said: "Because they were in my shoes. I felt like I could just talk to them like we're on the same level and they wouldn't have that stigma of trying to ask a teacher about that kind of stuff so they could give me a little more information…" Similarly, other participants described feeling "like one of them," "comfortable," and "a sense of community."

Tied to the notion of similarity is that low-income and Latino/a peers can reassure one another that their unique, prior life experiences and knowledge are valuable. Over time, as these students form friendships and develop peer networks, they might intuitively model one another based on behaviors that are not self-defeating but self-empowering.

Theme 3: General Support from Family Members and Significant Others

Up to this point, we have discussed how agents within the university site—faculty mentors, instructors, peer mentors, peer tutors, cohort members, and classmates—generally contribute to validating the low-income and Latino/a students in our study sample. Family members and significant others, too, express care and concern that are valuable to the success of underrepresented college students. However, the validation of these out-of-class agents is more nuanced than that of their in-class counterparts.

Parents, siblings, and significant others supported participants in their quest to earn a college degree in two ways. First, some of these agents provided encouraging comments about college during the participants' upbringings and during college. Such comments to participants came in several forms, including urging them to "realize their potential" or "take on a challenge," comparing the benefits of college over alternatives such as the military, and excitement about how much money engineering and computer science fields pay. A quote from a female student in mechanical engineering exemplifies these comments:

> I kind of dragged my feet in my first couple years of community college. But I've always had the ability to think logically or do well in math and science, so when my mom mentioned in the beginning of my community college career that I shouldn't waste that ability, that [I have] a talent I should take advantage of, she was right. And, yes, I do feel like everything that I've experienced—I don't regret any of it. I'm very grateful for all of it because it's brought me to where I am today. And it's helped me find this motivation and passion for what I'm currently doing.

Contrary to the sample in Rendón's (1994) study, the majority of the nontraditional students in our sample *did* grow up with the expectation of attending college. This is an important point: They held this view even if their parents lacked college degrees of their own. For many, going to college was implied rather than explicitly stated. Being low-income, most of our participants' families could not provide financial support, but they could affirm that their loved ones were "college material" despite socioeconomic conditions that frequently function as obstacles. As the quote above shows, validation about one's ability can be the determining factor in choosing to persist in college.

Second, when parents, in particular, did not offer overt words of encouragement to their children, they demonstrated a unique way of pushing them toward college. Rather than paint the parents as "role models," several parents seemed to present themselves as foils—heuristic examples of what *not* to be. Participants repeatedly stated that their parents wanted "good," "happy," or "better lives than they had" for their children, and that the surest way of achieving either was through higher education. For example:

> My main motivation actually came when I was 14. When I was 14 I lived on a farm and my dad worked in the fields. One day he took me out on the fields and we were picking strawberries and lemons and working all day. And at the end of the day he asked me, "How did you like it?" I told him I hated it; I was tired, and he was like, "Well if you don't want to do this for the rest of your life, you better stay in school." And I did. (Male, ME)

For participants receiving similar comments, many felt obligated to finish college. While the motivation to earn a degree varied among participants, many reasons included the status of being the first person (or one of the few) in their family to graduate from, financially providing for their family, and serving as a role model for their family and community.

Summary of Findings and Implications

While we aim to enhance what we know about student support programs in engineering and computer science fields through this case study, we note specific limitations of our work. First, because a case study focuses on a single unit—in this instance, a student support program—we offer results and findings as a basis to transfer what we found to similar institutional contexts. . Indeed, given institutional differences between SCU and institutions of different control, location, and designation, the findings may not extend far beyond a select number of college and universities. This is a distinct limitation of single-site (institution and program, in this case) studies. Another limitation of our work is that we captured student experiences at one point in time, and these experiences relate almost exclusively to students' program experiences, not broader campus experiences. The latter experiences may differ somewhat from students' program experiences, and we did not explore these larger dynamics.

Despite these limitations, what we discovered in the results of our case study offer us insight into how underrepresented transfer students in engineering and computer science fields develop and frame their experiences. When we turn to validation theory, we find that the institutional agents in our study—faculty mentors, peer mentors, and family members—served as the primary contacts for underrepresented transfer students. In fact, members of these three groups generally initiated and sustained frequent contact with students via weekly program meetings (with faculty and peer mentors), out-of-class and out-of-weekly meetings (with peer mentors and tutors), and daily support from family members. Here, these formal (in-class, in-lab, and in-meeting) and informal (social and out-of-class) contact with multiple agents positioned students in relationship structures that offered mentoring support throughout their tenure as students at the university.

We also found that students experienced validation over the course of their two years as program participants. For example, from program orientations and socials to weekly meetings and summer research work, students traveled through a program process that started early in the post-transfer experience and continued towards program completion. Over time, these experiences seemed to facilitate their development as university students in upper-division majors and early career professionals in engineering and computer science fields. Simply put, they reported understanding more about how to navigate institutional and department norm and expectations of their professors and future supervisors. When validating experiences occur, students feel more confident (Rendón Linares & Muñoz). Throughout this study, we witnessed strong evidence suggesting that the students' sense of belonging and self-confidence increased in relation to their work with faculty mentors, peer mentors, and family members. These indicators ranged from simple faculty comments about student abilities to faculty research supervision that guided students into career fields.

Overall, the results from our study point to a possible approach working with underrepresented transfer students, particularly Latino/a and low-income students, that offers them multiple forms of validation by faculty, peers, and family members. In fact, the more frequent students encounter these validating experiences, the more likely they are to report developing skills to navigate academic and professional systems. These skills, in turn,enhance their sense of belonging and self-confidence as transfer students in engineering and computer science fields. These findings are all the more important given the pressing needs of transfer students, who tend to experience challenges in navigating post-transfer institutional culture (Lanaan, 2001; Cejda, 1997), particularly when they come from family and community backgrounds that have been historically underrepresented in and excluded from higher education institutions.

While validation theory can explain many participants' stories, their experiences did not align with all of the models' dimensions. Whereas faculty members addressed each of Rendón Linares and Muñoz's (2011) forms of interpersonal validation, they neglected a few forms of academic validation. Specifically, participants did not recount their instructors inviting guest speakers who share an underrepresented background similar to students in the classroom; nor did the students suggest that anything they read dealt with figures or events that resemble their personal histories. Lastly, the faculty members presumably did not give the participants assignments where they could write about their experiences as an underrepresented scientist. We should note that while students in our sample did not report these class experiences, faculty may have indeed done so. Speaking to why recognition of students of color in the curriculum is necessary, a male CSCIT student said, “Because [if] it's someone from my background and if they succeeded it makes me believe that I can too.” To be sure, the absence of these activities could be a normative pattern in engineering and computer science majors, and we are not faulting faculty for not implementing them but rather offering an explanation of how validating experiences of any kind tend to support students.

Further, participants’ experiences with faculty mentors were not consistently validating. While uncommon, some students expressed course instructors being insulting or discouraging of their goals. One professor even told a participant to switch majors. We should mention that these lecturers and professors were not necessarily affiliated with the Connect program, so program efforts in Connect or similar programs should address such negative experiences. Further, future research should explore underrepresented transfer student experiences—with faculty, peers, and family—outside of student support programs in engineering and computer science fields.

Given that validation theory offers insight into our results on multiple—but not all—levels, we encourage campus administrators seeking to understand why their support programs do or do not work—so evaluation research studies may follow this case study and examine the unique program components in relation to validation theory. Indeed, the overall conclusion of this study is that validation drives the positive experiences expressed by the students we interviewed. Through the use of institutional resources, including faculty, staff, and student resources—and strategic initiatives, campuses, departments, and programs can develop similar support mechanisms to promote student contact with caring and interested faculty, knowledgeable and involved peers, and encouraging family members. Further, deliberate activities that intentionally enhance student validation need to be incorporated into campus or department initiatives so that students do not simply enjoy time with instructors, friends, and family.

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