Abstract

The transfer pathway from community college to university holds promise for advancing equity in STEM because it is followed by disproportionately high numbers of underrepresented students. Among the challenges these students face is cultivating belonging in multiple institutional settings. By combining belonging and validation theories, this qualitative study investigated how underrepresented students' belonging developed in their STEM majors, highlighting differences between students who transferred and those who began as first-time in college (FTIC) students. The findings revealed that for each type of belonging experience a smaller proportion of transfer students than FTIC students experienced validation and a higher proportion experienced invalidation. Department-based transfer student orientation and ongoing programming were uniformly validating to STEM transfer students. The study provides evidence that major belonging is an academic phenomenon that is within the scope of institutional responsibility to improve. Practical implications for administrators and faculty are included as are suggestions for future research.

Keywords: STEM majors, underrepresented students, academic belonging, transfer students, validation theory, qualitative study

Validation of belonging among underrepresented undergraduates in STEM majors: Comparison of former transfer and non-transfer students

Retention and bachelor's degree completion in science, technology, engineering and mathematics (STEM) majors continue to have lower outcomes for students who are traditionally underrepresented in STEM fields, including women, Black and Latinx students, and those with low-income and first-generation in college family backgrounds (Chang et al., 2014; Espinosa, 2011). Except for the associate degree level, recent data indicate that Black and Latinx STEM degree recipients are progressively underrepresented at each stage of the educational pipeline in comparison to their representation in the overall U.S. population (Trapani & Hale, 2019). This underscores the potential promise of the transfer pathway from community college to university for advancing equity in STEM fields since disproportionately high percentages of underrepresented students begin their STEM studies and find success in community colleges (Institute of Education Sciences, 2020; Malcolm & Feder, 2016; Witham et al., 2015).

To better facilitate positive outcomes for transfer students a growing research base has shed light on numerous barriers and complexities associated with upward transfer and undergraduate degree completion (Bahr et al., 2017; Crisp & Nuñez 2014; Denton & Borrego, 2021; Dowd, 2012; Jackson & Laanan, 2015; Jackson et al., 2013; Nuñez & Yoshimi, 2016; Townsend & Wilson, 2006), including for underrepresented transfer students in STEM majors (Author; Author; Lopez & Jones, 2017; Packard et al., 2012; Wang et al., 2020; Zhang, 2022). While many factors have been found to predict successful outcomes, those related to students' backgrounds and personal commitments outside of academics are likely to be difficult to influence, while other factors may instead be more amenable to institutional intervention and catalyze talent development during students' pathway progression (Austin, 1990; Mullet et al.,

2017). This study focuses on one such factor, academic belonging, which previous research suggests is both a malleable and influential aspect of students' STEM major experience and completion outcomes (Hausmann et al., 2009; Strayhorn, 2019; Author; Hurtado & Carter, 1997; Rodriguez & Blaney, 2021; Walton & Cohen, 2011).

In line with foundational research on undergraduate student retention and persistence (Astin, 1984; Seymour & Hewitt, 1997; Tinto, 1975; Tinto, 1993) and emerging approaches to the application of belonging to higher education students and contexts (Bentrim & Henning, 2022; Strayhorn, 2019), we approach belonging developmentally as something that emerges, accrues, and fluctuates through students' engagements and interactional experiences in higher education contexts over time. We posit that belonging is an academic phenomenon that is within the scope of institutional actions known to influence student retention and graduation outcomes. Because of persistent disparities in outcomes for underrepresented students in STEM majors and the potential of transfer pathways for rectifying these inequities, this study examines how underrepresented students' academic belonging developed through validating and invalidating experiences in their STEM majors, highlighting differences between students who transferred into a university from a community college and those who began as first-time in college students. This question is important because it can provide evidence-based guidance to universities and departments within them about actions that should be taken to improve retention and outcomes for underrepresented students in STEM majors, including especially transfer students.

Literature on Belonging

Although theories of belonging emerge from multiple social science disciplines, as applied to education belonging research has roots in educational psychology (Halse, 2018). In this theoretical lens, belonging has been understood as a basic human need that individuals are

behaviorally motivated to satisfy through seeking interpersonal attachments (Baumeister & Leary, 1995). In school settings, belonging has been defined as the sense of being accepted, valued, included, and encouraged by others, especially teachers and peers (Goodenow, 1993). Scholars have generally viewed belonging as context-dependent, connoting membership and reflecting experiences of personal involvement and integration within a system or environment (McLaren, 2009; Strayhorn, 2019). Research in STEM higher education has consistently shown that belonging predicts satisfaction, achievement, major retention decisions, and intention to persist to degree completion (Hausmann, et al., 2009; Marra et al., 2012; Strayhorn, 2019). Moreover, belonging has been demonstrated to be a distinct attribute related to engagement that is not reducible to self-efficacy (Marra, et al., 2012; Tinto, 2022; Wilson, et al., 2015).

Belonging takes on a heightened significance in settings that individuals experience as unfamiliar and where they may feel marginalized, stigmatized, or unwelcomed. Research has shown that racially minoritized students in STEM are more likely to experience belonging uncertainty that can impede their academic progress in comparison to well represented students (Rodriguez & Blaney, 2021; Strayhorn, 2019; Walton & Cohen, 2007). Indeed, studies have indicated that underrepresented students in STEM majors commonly experience the opposite of belonging, due to occasions and interactions that prompt feelings of exclusion, alienation, disconnection, and isolation (Johnson, 2012).

Despite consistent results showing the importance of belonging in students' higher education success, with some notable recent exceptions (Bentrim & Henning, 2022; Strayhorn, 2019), relatively little research has focused on post-secondary academic belonging and theories about its underlying factors have seldom been empirically investigated (Slaten, et al., 2016). Further, the existing literature has not fully considered how the progressive nature of academic

degrees and majors may affect belonging at the undergraduate level. Most previous studies are cross-sectional and therefore measure students' belonging at a single point in time. Only a few studies recent studies of belonging have been longitudinal or considered belonging as a developmental phenomenon (Vaccarro & Newman, 2022), despite research suggesting that belonging can fluctuate over time (Hausmann, et al., 2009). In addition, studies have not uniformly operationalized belonging as an academic phenomenon, despite findings that it associates strongly with academic performance (Marra et al., 2012). Despite current limitations, scholars have explicitly called for adopting a belonging framework to better understand the disparities in underrepresented students' STEM transfer outcomes (Crisp & Nuñez, 2014).

The current study builds on previous research on belonging in higher education, which has mostly taken the campus as a whole or the classroom as the contextual locus of belonging (Freeman et al., 2007; Museus & Maramba, 2010; Wilson, et al., 2015), by focusing instead on the major and department level of students' academic belonging. Several recent studies are particularly relevant to our work. For underrepresented students in STEM, Rainey and colleagues (2018) found that a sense of belonging bolstered students' commitment to remain in STEM majors over time. They identified four factors as contributing to minoritized students' sense of belonging: interpersonal relationships (with faculty and peers), perceived competence in STEM, personal interest, and science identity. Belonging research is emerging about specific STEM majors, especially computer science (Blaney, et al., 2022; Charleston et al., 2014; Sax et al., 2018). Blaney and colleagues (2022) conducted a rare investigation comparing the belonging experiences of transfer and non-transfer students in university. They call for additional research that builds on their survey findings that showed that transfer students contrasted with non-transfer students in reporting a lack of support by peers in their major.

In addition to the paucity of longitudinal, major specific, and transfer student focused studies, relatively few studies of academic belonging have posed questions requiring a qualitative research design or relied on a phenomenological approach. One exception is Rodriguez and Blaney (2021) who examined the lived experiences of Latina students majoring in STEM. Consistent with previous research relating to underrepresented students, they found that Latina students often felt marginalized within academic STEM environments, faced skepticism from male peers, and navigated self-doubt and isolation during college. Notably, too, they identified several strategies through which Latina students built their sense of belonging and actively resisted marginalization, including engagement with identity-based STEM organizations (Rodriguez & Blaney, 2021). In another recent qualitative study of belonging involving mostly freshmen and sophomores, Slaten and colleagues (2014) described novel contributors to students' sense of belonging, including meaningful groupwork with peers, membership in student organizations, similar experiences to peers, opportunities for self-awareness and growth, and balancing social and academic lives.

A qualitative research approach would be useful in investigating the organizational side of belonging, including describing institutional practices that validate student belonging, which is one aim of the current study. Strayhorn (2019) contends that too little is known about the institutional side of belonging in higher education, specifically the organizational and institutional attributes, conditions, ethos, and practices influencing students' sense of belonging both directly and indirectly. Questions about the organizational context of belonging are particularly consequential to underrepresented students pursing membership in STEM majors through two- to four-year institution transfer pathways. To be successful these students must navigate belonging in multiple organizational contexts and successfully seek admission to

transfer to a university and often also into a specific STEM major and department (Author). This research contends that academic belonging for these students is a major specific and emergent phenomenon that is both shaped by institutional policy and normative practices as well as by strategic actions available to and taken by students (Rodriguez & Blaney, 2021).

Conceptual Framework

This study extends belonging theory through combining it with the framework of validation proposed by Rendón (1994), whose research focused especially on Latinx and nontraditional students in community college. Validation theory is premised on the idea that prior to entering college most traditional students, who are predominantly White and from financially privileged backgrounds, have already experienced a substantial amount of personal and academic validation. In contrast, nontraditional students--who Rendón defines as including low-income students, first-generation in college students, and many women and racial/ethnic minority students--are more likely to enter college with doubts about their ability to succeed. For these doubts to be erased, students need sustained and progressive external support in the form of intentional, proactive affirmations by institutional agents both in and out of the classroom (Rendón, 1994). Externally sourced validating experiences can move students toward acknowledgement of and increased security toward their own internal capacities and potential to succeed (Rendón Linares & Muñoz, 2011). Validation is therefore a prerequisite to student development (Rendón, 2002) that helps students gain confidence in their academic abilities and understand that college is not just taking courses but cultivating a "professional orientation to life and work" (662). Notably, too, in Rendón's formulation, validation like some models of belonging (Rainey et al., 2018; Strayhorn, 2019) is expressly connected to students' views of their competence and ability to succeed in college.

In Rendón's original model of validation (1994) as well as recent research applications of it to STEM transfer students (Zhang & Ozuna, 2015), the onus of validation is on institutional agents, especially faculty, advisors, and mentors, to be proactive in initiating constructive interactions with students and helping them gain confidence in their ability to succeed in college. While this emphasis is appropriate in countering the general neglect of faculty members' roles in student success in previous studies (Barnett, 2011), experiences of validation and invalidation among students in STEM majors may be broader and more complex and may coincide with additional context-specific factors that have been found to contribute to belonging in STEM, such as peer support, co-curricular involvements, and academic achievement. Hence, the potential value of combining these two theories. In addition, by examining belonging through the lens of students' validation experiences *in the organizational context of their STEM majors*, this study avoids the assumption made in some previous research that belonging is a non-academic factor that is beyond the scope of institutional responsibility to improve policies and practices.

Recent research that has combined validation theory with ecological systems theory gives credence to the idea that belonging validation and invalidation can result not just from direct contact with faculty and other institutional agents, but from additional opportunities and cultural dimensions of higher education contexts. Previous studies have found that the intentional adoption of an *ecological validation model* was associated with improved success outcomes among underrepresented students (Kezar et al., 2022; Kitchen et al., 2021). Academic validation, when embedded widely into institutional practices and programs, created opportunities for reassurance and second chances among underrepresented students, who felt more comfortable taking risks (Kezar et al., 2020). This finding is particularly relevant to underrepresented students majoring in STEM since STEM-specific grading practices, socialization, and other disciplinary

norms present higher risks than many other majors (Dowd, 2012; Rodriguez et al., 2012; Witteveen & Attewell, 2020), with these risks presenting extra burdens to students pursuing a STEM bachelor's degrees through transfer pathways (Bahr et al., 2017; Wang, 2013).

Methodology

This study is part of a larger, five-year, mixed-methods, descriptive case study of underrepresented students' experiences navigating their way to completing an undergraduate degree in a STEM major, with a special focus on students who transferred from a community college to a university. Case study research was selected because of its value for understanding complex systems in an in-depth manner (Yin, 2003), such as how student belonging in STEM majors develops through validating and invalidating experiences that occur over time. The three institutions included in the study were each public, comprehensive universities located in different states and were selected based on their demonstrated success supporting and graduating underrepresented students in STEM. To identify the institutions, we searched the federal Integrated Postsecondary Education Data System (IPEDS) for institutions with higher-than-average rates of enrollment and graduation for historically underrepresented students. Notably, this search yielded institutions that were moderately selective and more commonly attended by underrepresented students in contrast to highly selective institutions that have tended to be the settings of STEM persistence research.

Institutional Review

This study was approved by [the author's university's institutional review board] (Approval #X). Each study site's institutional review board reviewed the human subjects research protocol and accepted the approval of the author's university. To collect an initial population of seniors from which a sample was drawn, the team worked with participating

institutions' offices of institutional research using FERPA compliant directory information. Students were invited to participate in the interview study through an e-mail with a link to a sign-up solicitation verifying eligibility. Interested students then received an email further explaining the purpose of the project and what their involvement and including a copy of the informed consent for their review. For in person interviews, which were conducted at one institution, prior to the start of the interview the interviewer further explained the study with each participant and then secured signed consent before proceeding with the interview. For interviews conducted over Zoom, which was the case for two institutions, consent forms were completed by students either prior to or in a few cases at the beginning of the Zoom call with an interviewer. All study procedures, instruments, consent forms, and recruitment materials were reviewed and approved by the institutional review board.

Data Collection

This article is based on findings from interviews conducted with graduating seniors in STEM majors at the three universities. Our team of four qualitative researchers developed the semi-structured interview guide, which included questions about belonging, institutional climate, classroom experiences, interactions with faculty, interactions with peers, co-curricular engagement, advising, curriculum, challenges, and career goals. Former transfer students were asked about their transfer adjustment experience and first-time in college students (FTIC students) were asked about their early post-admission experiences. Data were collected during 2020 and 2021 and students were therefore reflecting on experiences that mostly, but not entirely pre-dated COVID-19 disruptions. At one institution, the interviews were conducted in person in late January 2020, just prior to COVID-19 disruptions. For the other two institutions, interviews were conducted in the fall 2020 and spring 2021 over Zoom due to COVID-19 restrictions and

uncertainties. Both in-person and Zoom interviews with students typically lasted 60 minutes. Participants received a small gift card for completing the interview. With students' consent the interviews were recorded. Recordings were fully transcribed, and these transcriptions were the data source for the study.

Participants

We selected a stratified sample of STEM students from each of the three institutions to invite to participate in the senior interview study, enrolling a diverse group of students in terms of race/ethnicity, Pell eligibility (as a proxy for low-income status), gender, and first-generation college status. We also sought disciplinary diversity in the sample, including representation across the physical sciences, life sciences, engineering, mathematics, and computer science/information technology majors. The current analysis draws on data from racially and/or economically minoritized seniors in the sample who retrospectively described belonging experiences that they encountered as part of their STEM major. This included roughly half former transfer students (n=23) and half FTIC students (n=25). Students in the full sample of seniors (n=112) whose background was not underrepresented in STEM, who had been dual enrollment students in high school, or who did not clearly describe belonging experiences during the interview (and therefore had missing data for that item) were excluded.

Data Analysis

This paper addresses the descriptive research question of what were the experiences of belonging validation and belonging invalidation that underrepresented students in STEM encountered in their undergraduate majors and how did these experiences vary by students' former transfer status? The analysis drew from coded domains for "student belonging," "institutional climate," and "challenges," which allowed for both deductive and inductive

analysis (Spradley, 1980). That is, coded data about students' belonging experiences were generated from direct questioning about belonging and from interview questions about institutional climate and challenges that students encountered over the course of their degree program. Initial coding was conducted by four researchers using NVivo software. Inter-rater reliability for the belonging code was 91.15 and was 94.06 for the climate code. A second phase of analysis involved inductive theoretical coding (Maxwell, 2012) of belonging data to identify instances of *academic belonging validation*, which was operationalized as an affirming experience such as encouragement by a faculty member, as well as *academic belonging invalidation*, which was operationalized as a doubt provoking negative experience such as being isolated from peers or earning poor grades. This second phase also included comparative analysis of differences in belonging validation experiences between former community college transfer students and FTIC students. Overall, we enhanced the trustworthiness and credibility of the research by randomly selecting students from within the stratified categories and by clearly operationalizing and defining codes among team members (LeCompte & Goetz, 1982).

Findings

Overall Patterns of Validating and Invalidating Belonging Experiences

While consistent with validation theory in revealing the importance of relationships with faculty for bolstering students' academic belonging, our overall results indicated additional organizational and contextual features of STEM undergraduate programs were also influential. Table 1 shows the percentages of FTIC and transfer students who spontaneously described different types of validating and invalidating belonging experiences in their STEM majors.

Table 1.

Types and distribution of belonging validation and belonging invalidation experiences

Type of Validating/Invalidating Experience	First-time in college students n=25	Former transfer students n=23
Academically like-minded peers ---- De facto cohorts	44% V (8% InV) 40% V (4% InV)	35% V (30% InV) 4% V
Faculty/Instructors ---- Mentors ---- TAs, graduate students	40% V (8% InV) 12% V 8% V (4% InV)	22% V (13%InV) 17% V 0
Academic clubs	20% V	13% V
Non-academic groups/clubs	8% V (8% InV)	4% V
Designated STEM student space	12% V	13% V
Grades/competence demonstration	8% V (20% InV)	17% V (35% InV)
Anchor of future STEM career aspiration	8% V (4% InV)	22% V (4% InV)
Time/duration of major study	36% V (4% InV)	8% V
Transfer student orientation/ special support	NA	39% V

Note: V= indicates the percentage of students who referenced a particular validating experience of belonging. InV=indicates the percentage of students who referenced a particular invalidating experience of belonging.

How each of these types of validating and invalidating belonging experiences played out for FTIC and transfer students during their STEM majors are detailed below.

Like-minded Peers and De facto Cohorts

While much belonging literature has affirmed the importance of peers in students' adjustment and success in higher education, among underrepresented students in STEM our results indicated that finding and relying on academically "like-minded" peers was validating regardless of students' transfer status. However, FTIC students enjoyed situational advantages in securing access to peers, reporting fewer invalidating peer access experiences in comparison to transfer students. Part of the source of this advantage was the de facto cohorts that resulted from FTIC students having taken major-specific prerequisite and required courses with the same students over several years. FTIC students described the validation generated by cohorts as like being part of a "family," such as a student majoring in internet communication technology:

> It's like a family but, we don't really know each other. I've had classes with the same 20 people every single semester. We know of each other, we know, this is how we are as ICT majors, we learn the same things so we all feel like we have the same knowledge of these subjects. I'd say everything is pretty unified, the teachers are great. No one really feels alienated, being an ICT major. (Black, Pell-eligible, male student)

A student majoring in biology contended that the "community" ethos was both more prevalent and more consequential to student success in STEM majors than other majors on campus:

> I think it is a community. We as STEM majors have more of a community than any other major because I speak to people that are business and marketing, and to be completely honest, I don't see a group... I feel you need that support. You need to work through topics together and [have the opportunity to] teach someone else. (White, first-generation in college, female student)

One FTIC student's experience of being placed ahead, in terms of curricular progress, of his actual status as an incoming freshman in engineering due to having taken advanced placement

courses in high school illustrated in reverse how coursework sequencing in STEM majors created belonging validation through de facto cohort formation among students:

> I came in ahead of everyone. I came in as a sophomore status. My first class here was a computer engineering class. Everyone in the class were second years or some were even third, but mostly second year students. I didn't find myself fitting very well because everyone already had their own groups, because they've already been on campus for at least a year and whatnot. I was just kind of the outsider and a little freshman nobody. (Asian, Pell-eligible, first-generation in college, male student)

Due to the nature of transfer timing from community college, many transfer students were disadvantaged in accessing a cohort of peers in their major. Although the validating effect of finding and connecting with academically like-minded peers was equally important to former transfer students, roughly a quarter had had to overcome initial challenges accessing these peers after transferring. For example, two transfer students who lived at home with family noted that this had disadvantaged them in connecting to academically like-minded peers. In both cases these students instead found validation through connections with faculty members in their major, as described further below. Even FTIC students sometimes had difficulties identifying who were peers in their majors because prerequisite courses in the first years of their studies included students from other majors, especially courses in math, physics, and chemistry. Requiring students to take major-specific courses early in the curriculum and requiring students to introduce themselves in courses at the beginning of a term were institutional practices that FTIC students described as making it easier to identify academically like-minded peers in their major.

In addition to classroom experiences, designated STEM spaces, internships, and STEM clubs were sources of both validation and invalidation of belonging connections to academically

like-minded peers among former transfer students. One student in physics had anticipated that after transferring to her university she would find like-minded peers that "really feel an interest in physics" in the same way she did. Unfortunately, peers in her courses were not as interested in physics, wanting to leave lab sessions early, which made her "feel like an outsider." She instead eventually found academically like-minded peers and validation in physics through interpersonal connections forged during a research internship:

> I had lab partners at my internship. They were all studying physics, they all really liked physics, and they all liked doing research. And it was also their first research experience. So, we were all working together, and asking a bunch of questions. That was a motivation, to know that there are other people that really enjoy physics and really want to do research. (Latina, Pell-eligible student)

Another transfer student had encountered competitive dynamics after transferring among her computer science peers in terms of grades earned and internships secured. This created belonging challenges and led her to question "maybe this isn't for me":

> There are sometimes when people want to compete with you. With STEM it's just so much of, 'Guess what I did this summer? Guess what internship I did? Guess what grade I got?' So much of that, and I don't really care to be honest. If you're better than me, just be better than me. I don't care. I just want to make friends. So, one of the hard parts was just being able to connect with people. (White, Pell-eligible, female student)

Faculty, Mentors, and Graduate Students

Faculty, mentors, and graduate students, in their roles as teaching assistants and step-ahead researchers, both validated and, at times, invalidated students' belonging in their STEM major. FTIC students described major-specific organizational practices and conditions in their

STEM majors as influencing the potential of finding validation through interactions with instructors and mentors. An FTIC student majoring in biology found it challenging to connect with the "pre-med" track students who were present in each of her courses. She also struggled to find like-minded students pursuing zoology and marine science within biology because they were few in number and "doing their own thing." For her, validation to belong as a Latina from a low-income background in the marine science track of biology instead came from interactions with mentors, faculty advisors, and peers that she already knew. Another Latina student who was majoring in chemistry found validation through interaction with a female graduate student in male dominated laboratory settings in her major. Gaining validation as a person who belonged in the lab community through informal conversations with her mentor that transcended chemistry helped this student gain comfort "asking questions" and "making mistakes" as a chemist.

Former transfer students had more uneven experiences than FTIC students forging validating relationships with faculty and graduate students that affirmed belonging in their major. Moreover, as will be further detailed, departmental culture appeared to shape the interactional context for these validating opportunities to emerge. For example, a transfer student in biology found that faculty in his major were interactionally distant and projected a lack of care for his success. He attributed his success instead to anchoring validation to his goals:

> It's what you put into it. It sounds very cliché but when you're in biology, these professors a lot of them are research professors. They have a lot of things going on and have multiple students. They don't care individually if you're successful in your courses. You have to care. (Black Latino, Pell-eligible, first-generation in college, male student)

In contrast, two low-income female students in computer science at the same university found validating relationships with mentors through their major. One described faculty as having

facilitated the special program in which she met her mentor, who was also a woman. In addition to "bonding" with her mentor the student believed the "connection" removed doubts she harbored about her ability to learn content in her major. The other transfer student connected with a faculty member in her major during transfer orientation at her university. Initially helping her to select courses for the upcoming term, the faculty member mentored the student and eventually offered her an undergraduate teaching assistantship. Her validation of belonging at her university and in her major extended from the proactive support of this faculty member, who made her "feel at home" on campus and "never made [her] feel like an outsider in his class." The student attributed her persistence and successful completion of her STEM degree as a transfer student to the faculty member, explaining:

> He didn't assume that I had prior knowledge and he was able to explain [programming content] effectively without that... And he was a very big part of me staying [at this university] because he was the first professor to give me the time of day and talk to me, to make sure I was comfortable and to understand that I [had] just transferred and didn't really understand what's going on. (Asian, Pell-eligible, female student)

Grades and Perceptions of Competence in STEM

Students' experiences with their grades, grading practices, and their own and others' perceptions of their competence in STEM (as reflected in their grades) were prominent sources of both validation as well as invalidation of belonging in a STEM major. Interactions with faculty and teaching assistances were commonly focused on students' grades and instructors' grading practices, including attitudes and ethos held by instructors about students' competence in STEM and the likelihood of their success in a course or major. Actual or perceived poor grades and academic struggle invalidated belonging by generating doubt for students about their

competence, ability to recover from missteps, and likely future success. For some students, these doubts were overcome; however, doubts contributed to a few students in the study switching majors.

Relying on high stakes assessment, weed-out courses, and curve grading as well as espousing doubts about student competence were instructor grading practices that consistently invalidated students' belonging in STEM majors. Notably, these belonging invalidations could occur not only in major courses taught within the department where a major was housed, but also in required STEM courses taught outside of a students' STEM major, such as chemistry and physics courses for biology students or required math and physics courses for engineering students. A first-generation in college FTIC student had "wondered if engineering was the best fit" for her during her first two years when she, like many engineering students, struggled with grades. This struggle compounded her doubts by "affecting her mentally." Another first-generation in college FTIC student majoring in biology had a bad experience in a calculus course in which she perceived the professor "hated me, personally." She described him as having taunted the class with disparaging remarks about their competence. These invalidating instructor practices precipitated broad doubts for this student about her competence as a STEM major, contributing to her failing additional courses. She recalled:

> He'd make fun of us. He'd say like, 'Oh, over 60% of the students fail my class.' He was really proud of it. And it was just a blow to my self-esteem because that was the first class I ever failed. And I [thought], 'This is my fault, this is all my fault, I can't do it'... So, then, I started failing more classes. I think I failed six of them. I was just really low, my freshmen and sophomore years. (Latina, Pell-eligible, first-generation in college student)

Since she was an FTIC student, she had time to recover and find and take advantage of academic help and personal support. After receiving accommodations and effective support services from a university-wide center, the student's doubts about her ability to succeed in required STEM courses and in her major dissipated. In turn, her grades improved:

> Once I went to therapy and received accommodations, I was feeling better about myself. And all my grades went up. It was really interesting to see that pattern. And I was really proud of myself then because I was doing way better.

With her doubts mitigated, the student leveraged her feeling of validation to pursue elective courses in her major, gaining the perspective that she can "learn from her mistakes":

> Right now I'm taking all science courses this semester, for fun. [Other students] make fun of me but having the confidence and accommodations has helped me move forward, to think, 'Okay, I learned from my mistakes,' and now I'm doing way better.

Notably, as FTIC students, both these young women had time to adjust and recover from a period of invalidating grading practices and academic struggle. However, some transfer students encountered grades-related invalidations and had less time to recover. This included competitive dynamics among students in their major and high stakes testing practices, including curve grading. A number of transfer students mitigated grades-related invalidations of their belonging by foregrounding their long-term career aspirations. Additional strategies students employed were seeking help, self-reliance, and consciously demonstrating their competence to themselves, including constructively navigating competitive dynamics among peers in the major.

Financially disadvantaged transfer students were at times aware that their opportunities to gain validation in a STEM major were constrained in comparison to their more privileged peers.

A transfer student in engineering recognized that her financial disadvantage was reflected in her grades:

> My own battles have been when I started to question, 'Is this [major] really right? Am I smart enough? Why is this [other] person getting a higher score than I am? Or why does this person answer right away and I'm still calculating?' So, I found that my biggest challenge was learning to realize, 'You may not get it right away, but you'll get there'-type-of-thing. Or [understanding], 'You don't know that person and what their path has been [compared to you].' My path hasn't been straightforward. I haven't been given as many opportunities and I know that that is reflected in my map. Because if I had better opportunities, [maybe] I would be doing better in school or I would have already finished. (Latina, first-generation in college student)

Faculty could be instrumental in providing transfer students with validating strategies to cope with grades difficulties. For example, a transfer student in computer science explained how her mentor had given her a more validating perspective on failure by sharing personal experiences that "messing up" does not mean a person is "stupid." As a result, the student instead came to understand her failures in a more validating light by viewing them as a function of timing and circumstances.

Academic and Non-academic Clubs and Special Programs

Both academic clubs and to a lesser extent non-academic clubs could be important sources of belonging validation for underrepresented students in STEM. As described above, academic clubs enabled students to find and connect with like-minded peers, including in terms of gender and racial statuses.

Several FTIC students described academic clubs as validating their belonging in a STEM major through membership in a discernible community of like-minded students. A Latina student described the chemistry student club as "a good way to meet people." Through it she was able to engage in fun and academically validating activities, ranging from football game tailgate gatherings to exam study review sessions. Importantly, the chemistry club provided her with access to step-ahead peers who had insider knowledge of future courses in the major. Another Latina FTIC student had been proactively invited to join the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) by another student who recognized their minoritized racial and STEM interest commonalities. Involved in SACNAS since her freshman year, the student had become the club treasurer by her senior year:

> Because I was a marine biology student, a student in marine ecology, she saw me. And she was like, she's Mexican and Filipina. She was like, 'Oh, you're brown and you're doing marine biology? Come join SACNAS.' And she was very adamant in getting me to join her, to join SACNAS. (Latina, Pell-eligible, first-generation in college student)

The student had also been involved for many years in the Marine Ecology Biology Student organization, which opened opportunities to participate in marine biology and marine ecology volunteer and laboratory participation activities, which validated her belonging despite past challenges connecting with peers in the broader biology major.

In addition to serving as a mechanism connecting students to academically like-minded peers, academic clubs were validating as a way to connect underrepresented students to faculty members. One biology student met her mentor, an assistant dean at the college level, through an academic club. The long-term validating relationship that ensued helped the student navigate the

ups and downs of her STEM major progression, balance personal loss and academics, and undertake future career planning:

> I would try to see her at least twice a semester...She's been there for when I've lost my closest relative, and she's been there when I lost my other two relatives. She's been there when my grades were down. She's always giving me a kick in the [behind] if I do something stupid. She's really strong and is someone that I aspire to be because she was also similar to me. Where I'm not getting a B.S. in my field, I'm getting a B.A. And she was like, 'Yeah, I have a B.A. too, but I also have a Ph.D.' So, she definitely opened up the doors to what I want to do. (Black Asian, Pell-eligible, female student)

Relatedly, in several cases, students attributed their belonging and persistence to the validating support and peer connections they had gained as underrepresented students in special campus-wide programs. For example, one student's experience with a support program for undergraduates from low-income backgrounds was effective for her because representatives had proactively reached out to her early on, when she had just entered the university as a freshman:

> If [the program] hadn't reached out to me once I got accepted into [the university], then I wouldn't have known about it. [But] if I didn't have that support, then I would have not stayed in college. I think I would have left because it was through that program that I was able to meet my friends and we got to live together. So, if you don't have that sense of community it feels like I'd be working against education rather than with it. (Latina, Pell-eligible, first-generation in college student)

While no transfer students described participating in Greek life, two FTIC students who rushed their freshmen years at their universities eventually found it to be invalidating to their belonging in STEM, largely because their Greek community peers were not academically like-minded. One

engineering student found validation instead in a STEM academic club after "changing friends" by leaving her sorority.

Our findings tentatively suggest that transfer students may have been less likely to find belonging validation through academic clubs. However, those who did connect to a club found notable validation through it. This was the case for two women majoring in computer science at the same university. For one student, involvement in two computer science clubs for women enabled her to connect with "a community of girls doing the same thing" in a field dominated by "mostly guys." This, in turn, helped the student overcome isolation and doubts about belonging:

> Just to have that community of girls that also are in the same [major] that I am is good. It helps form friendships, it helps [make you understand that] you're not alone, don't worry. You're not the only one that feels that way kind of thing. (Multiracial, Pell-eligible, female student)

After transferring, the other computer science student encountered invalidating peer competition in classroom environments, including with other women. This led her to wonder if she belonged in computer science. In contrast, she found like-minded and supportive validation among peers in several computer science clubs. As she summarized: "The clubs are what made me feel actually welcome in my major."

Duration of Study in a STEM Major at a University

There was both implicit and explicit evidence that underrepresented FTIC students in STEM majors were advantaged in accessing validating belonging opportunities and overcoming invalidating experiences in part due to having had more time to navigate their majors in comparison to former transfer students. As noted previously, part of this advantage manifest as a de facto cohort effect resulting from "seeing [the same students] for four years," as one student

characterized it. This longer duration of time that students had to take classes together facilitated access to peer academic support, insider knowledge about what courses and instructors to take, and even material support such as the loan of textbooks. Advantages also manifested for FTIC students in terms of being able to recover from invalidating problems with grades, including by accessing peer, faculty, and program support. One FTIC student majoring in biology was explicit in describing these time-in-university validation advantages in comparison to transfer students:

> I could not imagine my experience here without meeting the people that I met in my freshman and sophomore year. Everyone that I'm friends with now, 90% of them are from my freshman year, and I just can't see coming in junior year [and trying to find peers]. I have some friends here that are transfers and they all live in this one apartment complex. It's pretty much where all the international and transfer students live. And you basically throw them all in there, and you're like, 'Okay, you guys need to make friends. Here you go.' (White, first-generation in college, female student)

Transfer students were similarly aware of the disadvantages associated with having had a shorter duration of university study in their major, including disconnections from peers in their major who had pre-established groups already formed at the point that transfer students entered the major and university. One biochemistry student described this explicitly:

> One of the disadvantages I'd noticed was that for people who had gone to university all four years, they kind of get used to people in their major, people in their group. Whereas when you transfer, you're kind of just thrown into a group of people that have been there for a while or you align yourself with other transfers. (Asian, Pell-eligible, male student)

Similarly, a transfer student in engineering noted that building relationships, including finding like-minded peers of similar backgrounds even within one's major, takes time, which is scarce for transfer students in STEM.

Institutional and Departmental Contexts of Belonging Validation

Departmental Cultures

Whether they were FTIC or transferred from a community college, underrepresented students experienced contextual differences in the culture of belonging among STEM departments. Students described some departments as environments replete with validating opportunities, beginning with orientation and including access to academically like-minded peers, sources of academic and socio-emotional help, academic clubs, encouraging faculty, and major and pathway affirming co-curricular opportunities. In the cases of engineering programs at two of the institutions, students described their peers as welcoming and inclusive, including toward incoming transfer students. One student described her civil engineering peers as "the best people I've ever met in my life" who were "like a mafia of mutual support." Departments with relatively few undergraduates, such as physics and astronomy, were generally validating contexts because their small size facilitated connections with peers and faculty members. Providing departmental space for undergraduates to study and work together was especially validating. After transferring, students benefitted from directional support needed to identify and validate specialized choices within their majors, although about a quarter of the transfer students in the study struggled to access this support. Faculty behavior and attitudes were a significant contributor to departmental cultures of belonging. In several cases, invalidating experiences with faculty occurred in departmental contexts outside of students' major and home department, during prerequisites courses, especially in math and chemistry departments.

Transfer Student Orientation and Supports

For transfer students, our findings showed that belonging validation could be jump-started during transfer orientation programs. A student majoring in physics described that despite there being only one other incoming transfer student, her orientation included visiting the physics department and physics research laboratories, meeting with the head of the department, the head of undergraduate physics education, and the president of the student physics club, who all "welcomed us." These physics department representatives explained the curriculum, provided advice about coursework intensity, and described research opportunities to incoming transfer students. Another student, who had transferred into computer science, gained informal advice from a computer science faculty member who attended her transfer orientation. Yet another student benefitted from a long-term course for transfer students, which helped him "be social with other people and not feel alone." In addition to formal and informal aspects of transfer orientation programming, transfer students gained belonging validation during their transition into university by taking summer school classes prior to formal entry and by maintaining participation in STEM clubs and programs that they had joined during community college.

Language of Belonging

FTIC students at one of the three universities in the study gained validation in the form of learning discourse useful in self-reflection on their own and other students' belonging experiences. Three students explicitly described overcoming invalidations associated with "imposter syndrome." For example, a student who had majored in computer science and biology put off finding an internship due to imposter syndrome, which to him was a perception that "I'm not capable of doing that yet." Another student who majored in computer science likened imposter syndrome to "fight or flight," in which "you're looking for any safety or identification"

with other students in the major. Imposter syndrome was invoked to describe a period of doubts about belonging due to struggles with grades that eventually resolved. Students also referenced "inclusion," such as one who characterized the chemistry department at her university as being more gender "inclusive" than the physics department based on an invalidating experience she had had with a physics teaching assistant. Another student described how a non-STEM undergraduate research experience had validated her belonging as a Latina from a low-income background in a field, marine biology, that was both mostly white and included primarily students from financially privileged backgrounds. She described the validation she found by gaining language to understand the phenomenon of disparities in access to STEM that she had observed during her undergraduate studies but had not previously had the means to articulate.

Discussion

This study examined how underrepresented students' belonging in their STEM majors developed through validating and invalidating experiences, highlighting differences between transfer and FTIC students. Theoretically, the study extended belonging theory by combining it with validation theory (Rendón, 1994), in order to analyze academic belonging through the lens of students' validation and invalidation experiences in the context of their STEM majors.

The findings showed that both transfer and FTIC students encountered similar types of belonging validations and invalidations and that these largely align with research delineating underlying contributors to belonging (Rainey et al., 2018; Rodriguez & Blaney, 2021; Slaten et al., 2014). However, the findings also indicated that for each type of belonging experience a smaller proportion of transfer students than FTIC students reported experiencing validation and a higher proportion experienced invalidation.

The overall pattern of disparity between transfer and FTIC students included finding *academically like-minded peers*, which invalidated belonging for 30% of the transfer students, as well as connecting to *de facto cohorts of peers*, which validated the belonging of only one transfer student in the study in comparison to 40% of the FTIC students. Disparity was also evident in the prevalence of *validating interactions with faculty and graduate students*, which was twice as likely to be reported by FTIC students than by transfer students. At the same time, both FTIC and transfer students had roughly similarly incidences of *invalidating interactions with instructors*. *Mentorship* uniformly validated belonging for underrepresented students in STEM majors but was rarely reported by either FTIC or transfer students. Similarly, *involvement in academic clubs* uniformly validated students' belonging in their STEM major, although reported participation was low, especially among transfer students. Consistent with previous research, as a demonstration of STEM competence (Rainey et al., 2018), *experiences with grades* validated STEM major belonging, especially for transfer students. At the same time, however, grades-related experiences constituted the highest incidence of belonging invalidation for both groups, affecting over a third of transfer students and a quarter of FTIC students.

The findings generated some evidence about contextual differences at the institutional and departmental levels in the culture of belonging and related structures and practices influencing belonging opportunities for underrepresented students. At one of the three institutions in the study FTIC students experienced STEM major belonging validation through developing *reflective self-awareness about belonging* (Slaten et al., 2014), as demonstrated in their use of its discourse. By consciously labeling belonging invalidations associated with "imposter syndrome" and discerning STEM departments as being variably "inclusive," these underrepresented FTIC students may have been better able to overcome associated threats to

their belonging. In some cases, *transfer student orientation* and *ongoing post-transfer programming* were designed and implemented expressly to bolster incoming transfer students' STEM major belonging by introducing them to departmental agents and practices and continuing to support them as transfer students. Such efforts were the most commonly mentioned belonging validation (39%) by transfer students but were not uniformly available among those in the study. Within a single institution, findings indicated that different departments instantiated distinct *organizational cultures of belonging* for underrepresented students. Some STEM departmental contexts described by students were replete with opportunities to validate major belonging, while others were less so. Invalidating attitudes, grading practices, and interactions with faculty and graduate students could be particularly deleterious to students' STEM major belonging; and in the reverse, validating engagements with faculty and graduate students strongly bolstered academic belonging, both directly and indirectly by counteracting the invalidating experiences some student encountered with peers and grades.

Implications for Practice

Overall, our findings showed that underrepresented FTIC students had more time and therefore more opportunity for belonging validation in their STEM majors, contributing to these students' higher incidence of connections with faculty and like-minded peers in their major and opportunities to gain belonging reassurance (Kezar et al., 2020; Vaccarro & Newman, 2022) in comparison to transfer students. In terms of organizational practice, this means that institutions and departments should target services and practices to compensate for the situational disadvantage of STEM transfer students in order to improve their retention and success.

For some departments, this means creating and implementing major-specific transfer student orientation and ongoing induction opportunities. For other departments, it instead means

building on what already works through expanding departmentally-based transfer student orientation programming to include proactive facilitation of transfer student participation in academic clubs and undergraduate spaces and activities as well as access to mentorship that includes support in overcoming grades-related invalidations and personalized STEM major navigation and career guidance.

At the whole institution (campus) level, administrators and leaders may need to incentivize departments to adopt practices that are aligned with a validating culture of belonging and underrepresented student success (Kezar et al., 2022; Kitchen et al., 2021). Campus level leadership and intervention in major-specific domains may be especially necessary for some STEM departments that continue to perpetuate exclusionary and competitive student development norms, which create high risk environments for underrepresented students in general (Dowd, 2012; Rodriguez et al., 2012; Witteveen & Attewell, 2020) and for transfer students in particular (Bahr et al., 2017; Wang, 2013).

One way to frame the cultural changes that may be needed within departments to bolster underrepresented students' belonging in their STEM majors, and therefore their retention and success, is to promote the perspective that validation is a prerequisite to student development (Rendón, 2002). Arguably, universities are in the business of student development, and at the department level students' majors are central features of this development. Validation theory contends that validating experiences help students gain confidence in their academic abilities and understand that *college is not just taking courses but cultivating a professional orientation to life and work* (662). The results of this study suggested unevenness among departments and faculty about whether undergraduate belonging in a major does in fact include cultivation of a professional orientation rather than simply completing a curriculum and requirements to obtain a

degree. Department-wide discussions about and consensus around this issue could prove useful in efforts to adopt changes conducive to creating a culture of belonging.

Relatedly, simply cultivating STEM department and major-level awareness and acknowledgement of which students are in a major and are therefore emerging *members of a discipline*, including those who have recently transferred, would be crucial starting points for developing and implementing a culture of STEM belonging validation. The results of this research suggest that the absence of belonging validation opportunities may undermine transfer students' ability to cope with doubts, overcome missteps, and persist to graduation. Even underrepresented FTIC students in large STEM majors, such as biology, cited invalidating experiences early in their degree program that were mitigated only after students began to access courses, as juniors, where they could identify peers in their major and had access to major- and career-specific course content and faculty attention.

FTIC and former transfer students in the study had both validating and invalidating belonging experiences with faculty members. Importantly, for some transfer students validating interactions with faculty compensated for invalidating experiences and mentors proved to be particularly helpful in providing reassurance and guidance through their major. Unfortunately, some faculty and graduate student interactions with students invalidated their belonging. Invalidation was especially acute when it occurred in ways that increased students' doubts about their competence in a STEM major. Faculty and graduate students who are unable to refrain from making taunts and disparaging remarks that undermine students' sense of their developing competence and potential to succeed in a STEM major should not have access to underrepresented undergraduates regardless of their tenure status or teaching obligations to a university. Relatedly, faculty responsible for specific STEM majors could productively

incorporate opportunities for students to learn from their mistakes and gain belonging reassurance through demonstrating competence not only through grades, but through additional means, such as formative assessments, project-based opportunities, and co-curricular activities.

Implications for Future Research

Prior scholarship anchors belonging in contexts, systems, and environments but provides little insight into how the culture of belonging in those settings influence student experiences and outcomes (Tonso, 2006). Studies have demonstrated that academic belonging and validation can be positively influenced by external interventions (Walton & Cohen, 2006); however, outside of the implementation of special programs (Kezar et al., 2022), there is limited understanding of what day-to-day organizational attributes, conditions, and ethos give rise to belonging (Strayhorn, 2019). Findings from this study provide suggestive evidence that students' STEM major belonging experiences were influenced both positively and negatively by department context. Future discipline-specific research on academic belonging is needed to further describe and understand the impact of departmental cultures of belonging and its implications for student retention and outcomes (Strayhorn, 2019).

Given the variability of faculty and graduate student impacts on the STEM major belonging of the underrepresented students in this study, future research should examine what influences this variability. How malleable to change is the behavior of institutional agents who have sway over underrepresented students' academic belonging as a consequence of departmental culture, reward structures, or punitive measures? What incentivizes and what impedes institutional agents' validation of undergraduates' academic belonging in their major? It is also unclear how common and consequential are departmentally-based efforts to identify and target the belonging needs of transfer students. The current study revealed instances of faculty

providing proactive validation to transfer students, but it was unclear what animated this support and why some former transfer students did and did not have access to it.

This study found promise in bringing belonging and validation theories together, and future research could elaborate this approach. Consistent with a growing literature that has identified operational underpinnings of belonging (Rainey et al., 2018; Rodriguez & Blaney, 2021; Slaten et al., 2014), our findings pointed to the validating and invalidating roles of faculty, peers, grades, academic clubs, and designated STEM spaces. In contrast to some previous research (e.g., Marra et al., 2012), this study found that student experiences with grades was central to their academic belonging. Future research on academic belonging should define and operationalize contributors to belonging validation in measurement terms that are clearly related to major-and context-specific teaching and learning practices and student experiences. While this study attempted to capture retrospectively how belonging developed over time, future major-specific research on academic belonging validation that is truly longitudinal would be important. Absent from the current study were the underrepresented FTIC and transfer students in STEM majors who had switched out of STEM or dropped out of university altogether prior to their senior year. Future research should directly investigate the extent to which academic belonging invalidation contributes to poor retention in STEM majors, including especially among transfer students. Finally, our findings showed that students at one institution had developed some fluency with the discourse of belonging. It may be important to understanding how this may benefit students including how this knowledge constitutes a strategic asset in their navigation of STEM major belonging.

Conclusion

Belonging has been described as a broad concept that has been vaguely defined and under-theorized (Halse, 2018). Higher education studies have not consistently defined belonging or operationalized it distinctly from related constructs, such as engagement (Strayhorn, 2019). This study demonstrated the value of elaborating belonging theory through combination with validation theory: for belonging theory, the validation construct represents a means of explaining why specific student experiences bring about positive and negative influences; and for validation theory, the belonging construct extends both the timeframe and types of experiences that may impact students' beliefs in their ability to succeed in college. Importantly, too, this approach provides an explanatory underpinning to belonging theory that is based on organizational practices and students' resulting experiences rather than in recourse to the generic fulfillment of basic human needs. In addition, by examining belonging through the lens of students' validation experiences in the organizational context of their STEM major, this study demonstrated that belonging is a thoroughly academic factor, bound up in student experiences with coursework, peers in their major, grades, and interactions with faculty and instructors. As such, this study has shown that belonging is actionable and should be considered within the scope of institutional responsibility to improve related policies and practices.

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