

Fostering a Sense of Belonging: An Investigation of a College of Engineering Support Center for Native and other Minoritized Students in Engineering and Computing (Work in Progress)

Dr. Susan B. Kelly, Montana State University - Bozeman

Co-Author, Dr. Flynn Murray, MSU Bozeman

Dr. Flynn Murray, Montana State University - Bozeman

Assistant Teaching Professor, Civil Engineering

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Abstract

Sense of belonging refers to the perception or feeling that individuals have of being connected, accepted, and valued within a particular group or community. Understanding this sense of belonging is crucial, as extensive research indicates that an increased sense of belonging is directly linked to positive academic outcomes, improved student experiences, and higher retention and graduation rates. This is especially critical for women and racially minoritized students in STEM—including Indigenous, Latino, and LGBTQ+ individuals—who often encounter exclusionary climates. This Work in Progress (WIP) examines a specialized College of Engineering support center at a public, land-grant university in the rural Western United States. Utilizing a concurrent mixed-methods survey of current students and recent alumni, this study investigates how center interactions influence perceived belonging through the lens of Third Space Theory and belonging. The theoretical framework, research design and limitations, survey rationale, and initial findings from the pilot survey deployment are briefly discussed in this Work in Progress, as well as the next analytical steps and future work.

Introduction

Students' sense of belonging is widely defined as the perception or feeling that individuals have of being connected, accepted, and valued within a particular group or community [1]–[3]. Understanding students' sense of belonging is crucial, as an increased sense of belonging has been linked to various positive academic and psychological outcomes for undergraduate students [4]–[6] and is a documented predictor of student success [7], [8]. This is particularly true for women and underrepresented students in engineering and other areas of STEM, who report a lack of sense of belonging in these settings [2], [9]–[13]. These feelings are even more pronounced for racially minoritized students [13]–[15], where Black, Indigenous, and People of Color (BIPOC) students are significantly underrepresented in STEM fields [16].

Studies suggest that students' sense of belonging can be positively impacted through academic and psychosocial validation, which increases with growth mindset development, a positive classroom climate, appreciation of diversity, faculty connection, and peer relationships [17]. Student support centers housed within academic colleges or departments can act as a nexus for these services and create a sense of belonging through interpersonal and academic support, which is critical for student retention, particularly in STEM fields [18].

While existing research on Engineering Student Support Centers (ESSCs) has largely focused on their organizational configurations and their role in providing academic or professional “hubs” for students [18], this study offers a novel contribution by investigating an ESSC specifically as a “Third Space” [19]. This theoretical application shifts the focus from traditional models of student assimilation into traditional engineering culture toward a model of identity

transformation and cultural congruency. By examining a specialized center within a rural, land-grant institutional context—a setting often overlooked in broader STEM belonging literature [11], [14]—this work investigates how minoritized students leverage their home “funds of knowledge” [20] to navigate and redefine the typically exclusionary culture of engineering. Thus, this study moves beyond measuring integration to exploring how the center facilitates a hybrid socio-critical space where students marginalized and academic identities merge, providing a deeper understanding of persistence for those historically excluded from the field.

This Work in Progress (WIP) examines a specialized college of engineering support center at a public, land grant university in the rural Western United States. This study investigates how students use or do not use center resources, and how these interactions influence their perceived belonging through the lens of Third Space Theory [19]. Using a concurrent mixed-methods survey of current students and recent alumni (graduated in the last three years), we investigate how a dedicated student support center can foster cultural congruency and persistence for students historically excluded from engineering and computing.

To contextualize this investigation, it is important to note that the center was established over 35 years ago with an initial mission to support Indigenous students navigating the engineering and computing curriculum and, more recently, other areas of STEM. Over the last four years, the center has expanded its mission to serve a broader array of identities, including Latino, first-generation, rural, LGBTQ+ students, and students with disabilities—recognizing that students hold multiple identities that are intersectional.

Despite the center’s expanded reach, the core philosophy remains rooted in the belief that for a student to persist in engineering, their “First Space”—the cultural, community, and home knowledge, or the “funds of knowledge” [20] they bring with them—must be validated by the institution [19]. In traditional STEM environments, this “First Space” is often suppressed in favor of the “Second Space”—the formal, often rigid expectations and institutional requirements of the larger university, the engineering college, and individual instructors.

To address this, the center functions as a “Third Space”—a transformative collaborative hybrid space where students are not forced to choose between their cultural identities and their professional aspirations. This WIP outlines preliminary results from a baseline survey designed to measure how this legacy space supports students’ ability to co-create their own identities in engineering, computing, and other areas of STEM. We ask, how/if a specialized engineering support center at a rural, land-grant institution functions as a Third Space to facilitate cultural validation and student agency for both current undergraduates and recent alumni?

Theoretical Framework

This study is grounded in the intersection of Sense of Belonging and Third Space Theory [1], [19]. Strayhorn [1] and others [7], [11] have established that belonging is a basic human need that is particularly salient for students in “chilly” STEM climates where they may feel unseen and undervalued. However, to understand how a student support center facilitates this belonging,

the authors utilize Gutierrez’s concept of the Third Space [19] which she applied in an educational context.

In this framework, the First Space represents the students’ home and community knowledge and their lived experience and practices, while the Second Space represents the formal, often rigid, expectations of academia. In this study, the Second Space (Institutional Navigation) is represented by the formal academic environment and the institutional resources provided by a college of engineering. The student support center serves as a critical bridge for students navigating this space by centralizing access to academic support, with services like targeted free tutoring and academic advising, resources for scholarship applications, and resume writing. In addition, the center provides direct links to faculty and professional staff, which research identifies as a key factor in enhancing sense of belonging [18]. The center is positioned as a Third Space, a transformative site where these two often–conflicting identities can merge. This allows students to negotiate their professional identity without sacrificing their cultural heritage and personal identities, thereby fostering ‘academic and psychosocial validation’ needed for retention in STEM. Drawing upon Gutiérrez’s framework of sociocritical literacy and Third Space Theory, this study operationalizes the expected outcomes into four measurable constructs: Identity and Validation, Institutional Navigation, Co–Creation and Agency, and Belonging (Table 1).

Table 1. Analytical Framework for Survey Instrument

Construct	Theoretical Lens	Example Survey Focus
Identity & Validation	First Space: Cultural/Home identity (Gutierrez, 2008)	Feeling like one’s “true self” in the center.
Institutional Navigation	Second Space: Academic/Professional identity (Gutierrez, 2008)	Understanding the written and “unwritten” rules of academia
Co–Creation & Agency	Third Space: Transformative overlap (Gutierrez, 2008)	Having a voice in center activities or environment
Belonging	Belonging, (Strayhorn, 2012)	Seeing center as a “safe harbor,” a refuge, or as safety

Methods

Instrument development

This study employs a concurrent mixed–methods survey design, where both quantitative 5–point Likert scale data and qualitative open–ended responses are collected simultaneously. An iterative validation design process was used. Survey items from previously validated surveys that examined student belonging were used as a starting place for instrument design, and additional questions were created to address the specific context and activities of the center. The survey was then structured into four blocks to align with, and measure, the four constructs identified in Table 1. To ensure the psychological safety and anonymity of this specific cohort, demographic data collection was intentionally limited to prevent deductive identification. This baseline 29-item instrument serves as a benchmark for future annual center assessments, and to collect

information that will inform future center retention strategies. Pilot data will be used to refine and rephrase questions to improve survey content and face validity. Following refinements to the questions after the pilot phase, Cronbach's alpha will be calculated for each construct in the main study to assess internal consistency reliability (construct reliability). The improved survey will then be administered to a larger student population that interacts with the center.

Participant Identification and Study Context

The center operates within a rural land-grant institution, serving a self-identified community of ~300 students (subscribed to a center listserv), with approximately 80 unique visitors engaging with the physical space weekly, and varying numbers of students (from 150 to 250) attending additional professional development or community building events. However, a gap exists between this "Active Population" and the broader "Eligible Population" identified by college-level census data (e.g., First-Generation, rural, Pell-eligible, or minoritized students). One goal of this survey is to utilize the "Active Population", partially captured in the pilot data, as a diagnostic group to identify the pathways and Third Space hooks that can be leveraged to reach the wider, target population, and to improve the survey instrument before it is administered to the larger sample.

Data Collection Timeline

This paper presents a preliminary analysis of the first wave of data (N=22) collected during a three-day pilot window in January 2026. This initial phase targeted 'high-engagement' users to validate the survey instrument and the theoretical coding schema. Following this submission, data will be fully analyzed, and the survey instrument will be refined as needed. The survey will be deployed to the broader college community (N=~300) over a three-week period. This tiered approach allows for an iterative analysis: the "Pilot Phase" establishes a baseline of Third Space agency among center leaders, while the "Full Deployment Phase" will investigate the barriers and belonging levels of the broader target population.

Data Analysis Plan

The data analysis for this mixed-methods study will integrate both quantitative and qualitative approaches to provide a holistic understanding of the center's impact. The quantitative component will involve the use of descriptive statistics to evaluate the means across four distinct theoretical constructs: Identity/Validation, Institutional Navigation, Co-Creation/Agency, and Belonging. The open-ended qualitative responses will undergo thematic coding using a hybrid approach, integrating both predefined categories derived from the Third Space framework (deductive) and allowing novel themes to emerge from the data (inductive) to systematically identify evidence related to the concept of belonging. The final stage of analysis involves data integration, where the qualitative data, or participant "voice," will be used to expand upon and contextualize the numerical trends observed in the quantitative results. This

approach ensures a comprehensive view of the program's outcomes by linking empirical data to the broader theoretical framework of the study.

After the pilot data is comprehensively analyzed using the analytical framework, additional inductive themes will be added, and survey questions refined in an iterative process, with the final survey shared with the larger center community. After data is collected from the full survey, quantitative data will be described using descriptive statistics. Both authors will employ an inter-coder reliability (ICR) protocol on the qualitative data. Using a preliminary codebook, both researchers will independently code a representative subset (approximately 10–20%) of the data to test for consistency.

Inter-coder agreement will be quantitatively assessed using percent agreement and Cohen's Kappa (κ). We establish a target threshold of 80% for percent agreement and a Kappa value of 0.70 or higher, which is categorized as "substantial agreement" in the Landis and Koch framework [21]. Any coding discrepancies will be resolved through a formal reconciliation process, where coders will engage in dialogue to reach a 100% consensus agreement for the final dataset.

Preliminary Results

The small pilot sample (N=22) represents a diverse cross-section of the center's community, that include undergraduate students (64%), graduate students (5%), and alumni (31%).

Demographically, the group is composed of 50% women, 36% male, and 14% non-binary respondents, with 36% of those students surveyed identifying as first-generation students. A high concentration of "Super-Users" is present in the data, as 68% of the surveyed students serve as center tutors or ambassadors, and 67% of respondents visit the center 4 or more days a week. Participants say they use the center to study (86%), or to get or receive tutoring (91%). They also use the center to meet friends (73%) or find new friends (64%), and either help other students while in the center (59%) or receive help from other students (68%) or staff (59%).

Quantitative Findings: Mapping to the Framework

Selected questions from the pilot survey are shared below to demonstrate how questions map to the theoretical framework, and how framework constructs can be applied to the data. Data interpretation will likely shift, as the data from the full survey is analyzed, and insights from the iterative hybrid coding of the qualitative data inform integrated data analysis. Likewise, further data analysis will inform the revision of survey questions so that constructs are more accurately measured. We share the "first pass" of data analysis in this WIP process.

The first question set (Table 2) uses a "Then-Now" retrospective pre-test for items focused on the identity (First Space), institutional navigation (Second Space). Differences in before and after mean scores are shown, and construct coding is applied (Space column).

Table 2. Retrospective Questions Using Third Space Analytical Framework

Question: For each statement, please select the rating that best describes how you felt <i>before</i> you started coming to the center, and <i>how you feel today</i> . Scale: 1 (Strongly Disagree) to 5 (Strongly Agree).	Space	Mean/(SD) (Before)	Mean/(SD) (After)	Delta
I see myself as a "real" engineer, computer scientist or STEM professional in my field.	3	3.26 (1.07)	4.00 (1.18)	+0.74
I feel comfortable interacting with faculty and attending office hours.	2	2.74 (1.22)	4.30 (0.86)	+1.56
I am aware of resources at [university] and in the college of engineering that can help me better navigate the university and be more successful.	2	2.22 (1.02)	4.52 (0.88)	+2.3
I use resources at [university] and in the college of engineering that help me better navigate the university and be more successful.	2	2.30 (0.91)	4.04 (1.16)	+1.74
I feel I have the tools to bounce back from a poor grade.	2	3.09 (0.72)	4.39 (0.71)	+1.3
I know who I can talk to if I need help with an issue that comes up for me.	1	2.65 (1.13)	4.74 (0.61)	+2.14
I feel certain I will graduate from [the university] with my STEM degree.	3	3.48 (1.10)	4.74 (0.53)	+1.26

A second example question set uses current–state Likert items (1 = Strongly Disagree to 5 = Strongly Agree) to examine First, Second, and Third Space constructs, in addition to the Belonging construct, with item mean scores and potential construct coding applied showing First Space (1), Second Space (2), Third Space (3), and Belonging constructs (B) (Table 3).

Table 3. Current–state questions examining theoretical constructs.

Question Scale: 1 (Strongly Disagree) to 5 (Strongly Agree)	Construct	Mean	SD
I feel that students have a voice in how the [center] is organized and used.	3	4.70	0.62
In the [center], I feel I can be my 'true self' without leaving my cultural or personal background at the door.	1	4.65	0.75
The [center] helps me understand the 'unwritten rules' of being a successful engineering, computing, or STEM student.	2	4.13	0.85
The physical environment of the [center] (décor, layout etc.) reflects the culture and identity(s) of students like me.	1	4.48	0.83
I feel like I have the opportunity to shape the environment and activities of the center (e.g. suggesting events, rearranging space, adding décor etc.).	3	4.35	1.0
The [center] is a space where I feel I truly belong.	B	4.78	0.51
I feel a stronger sense of community at the [center] than I do in my general STEM classes.	B	4.52	0.77
The support I receive at the [center] makes me feel more confident that I belong at [the university] as a whole.	B	4.70	0.46
Feeling like I belong at the [center] makes it easier for me to handle the academic challenges of being a student.	3	4.43	0.82
I have developed meaningful friendships with other STEM students at the [center].	B	4.35	0.96
I find people that help me persist in my major at the [center].	3	4.13	1.03

Qualitative Findings: Student and Alumni Perspectives

Table 4. provides an initial example abductive coding scheme based on informed-grounded theory, where codes are informed by both the theoretical framework and through themes that emerge from the data. The coding scheme will be modified and refined through iterative review of all qualitative data and then applied in an integrated data analysis process.

Table 4. Sample Preliminary Coding Scheme for Open-Ended Survey Questions.

Theoretical Construct	Keywords (Operational identifiers)	Example text from participants	Analytical Significance
FIRST SPACE (Cultural/personal Identity)	Home, Family, Roots, Culture, Traditions, "Who I am," "Where I come from."	"I don't have to leave my identity at the door."	Validates students "funds of knowledge" and cultural wealth.
SECOND SPACE (Institutional Navigation)	Tutoring, Grades, Advising, Credits, Requirements, "Getting through," "The College."	"This place helps me navigate the engineering college."	Highlights center's role in institutional persistence.
THIRD SPACE (Ownership/Agency)	We, Our, Co-author, Created, Voice, Suggestion, Change, "My space," Ownership.	"I have the power to shape this environment."	Provides evidence of student agency.
THE "REFUGE" (Safety/Belonging)	Safe, Breathing room, Recharge, Quiet, Escape, "The only place where..."	"The center is a buffer in a place that doesn't look a lot like me."	Identifies center as a "safe space" in the dominant college environment.

Discussion

Preliminary analysis of pilot data suggests that the survey design captures our desired constructs. Encouragingly, retrospective mean scores indicate growth in students' ability to navigate the institutional environment after engaging with the center. Current-state Likert items also suggest that students see their cultural and/or other identities supported in the center and feel a high degree of agency within the space. The degree to which this holds true will be seen after the survey is deployed beyond the pilot. Because of the small number of respondents, description of the intersection of students' identities is limited in this WIP. A more robust discussion of intersectionality will be addressed in future publications that include survey results from the larger student population who interact with the center.

Importantly, the "first pass" analysis also suggest that revision to survey items could improve fidelity of the data collected. For example, the fifth item in Table 2, *I feel I have the tools to bounce back from a poor grade*, demonstrates the need for survey instrument refinement because its ambiguity allows for plausible coding under two distinct analytical themes: Institutional Navigation (if "tools" means formal resources) and Refuge (if "tools" means personal resilience or psychological safety). This lack of clarity suggests that the item does not map distinctly to a single theoretical construct, indicating a need for clearer phrasing in future iterations of the survey. For example, *I know how to use university resources (e.g., tutoring, academic advising)*

to recover from a poor grade, maps to Institutional Navigation, while *I feel I have the personal support system needed to recover academically after a setback*, reflects the Belonging construct. Completing pilot survey data analysis and iteratively refining both the questions and the coding scheme to best reflect the analytical framework and surface any additional themes in the data will improve the final survey instrument that is deployed to the broader center user group.

Preliminary analysis of the open-ended responses suggests that while the center is highly valued as a Second Space for academic navigation (e.g., tutoring and advising), data also shows that the center supports both Third Space agency, and a sense of belonging. In initial review of the data, participants identified the center as a critical intervention for persistence, with one respondent noting they were "ready to take a leave of absence" before starting to use the center. Another respondent stated that the [center] was the "main reason I was able to finish my [degree]." Responses describe a fundamental shift from feeling "lonely" or "struggling with classes" to finding a community that "can really make or break college sometimes." Furthermore, students highlighted the center as a unique sanctuary within a college that is "primarily white and male" and the "only place on campus that actually cares." The sense of agency fostered at the center carried into professional life, with one alumnus directly crediting their current "engineering job" and professional "confidence" to the sense of belonging they developed within the space.

The pilot results confirm that the center effectively moves students from a state of low institutional confidence into a state of high navigational ability (Second Space). Furthermore, the high current-state scores for ownership suggest that the center successfully functions as a Third Space for its most active users. This is likely influenced by the high concentration of "Super-Users" in the pilot group; (68% of current student respondents serve as tutors or ambassadors), placing them in direct "co-author" roles.

Limitations

A primary limitation of this WIP is the focus on "self-identified" participants who are already active within the center's ecosystem. While these "Super-Users" provide deep insight into the co-authorship of the space, a notable limitation is the potential for self-selection bias; students and alumni who felt a strong connection to the center are more likely to participate in the survey, while those who did not find the space helpful may be underrepresented. The current survey respondents present only a fraction of the total student population who qualify for the center's support based on identity or background. Future research will involve "Outward-Facing" data collection, targeting students on the broader college listserv who do not currently utilize the physical space to identify barriers to using the center, and enhance the center's role as a college-wide Third Space.

Future Work

The primary focus of this WIP is to refine the analytical framework and survey instrument. Upcoming work will include a complete analysis of all 29 questions from the pilot data to inform the larger survey. This revised instrument will be completed by a larger user group in the college of engineering and the university. While this study used Third Space Theory to explore the dynamics of belonging, future research will employ sociocritical literacy as a lens to examine the specific mechanisms of student agency and identity formation within the center.

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