Understanding international engineering doctoral students’ sense of belonging through their interpersonal interactions in the academic community

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Introduction and Background

This study explores the ‘sense of belonging’ from the international student perspective. We seek a
greater understanding of the following: 1) experiences that contribute to international students’ perceived
sense of belonging, and 2) contributors to international students’ perceived quality of interactions with peers
and faculty. A qualitative research approach using the critical incident technique with a constructivist
perspective was used for this study. The overall results, and in particular understandings about the concept
of ‘sense of belonging’ that emerged from the students’ lived experiences, will provide insights for
developing an improved and inclusive institutional support structure for international students within U.S.
engineering doctoral education.

Sense of belonging

Sense of belonging is defined as ‘a fundamental human need for individuals to belong and to be
respected, valued members of a group or community of people’ [1]. The concept is a key indicator of
academic integration and intentions to persist. Sense of belonging also serves as a measure of the perceived
inclusiveness of an academic unit [2]. Spady [3] first mentioned sense of belonging as a precursor to the
concept of integration in higher education. Tinto [4] later developed a model for student integration that is
still widely referenced, but criticized because potential indicators of sense of belonging that occur outside
of the classroom (e.g., space and socio-cultural facets) were de-emphasized [5]. The student population at
all levels of education continues to diversify resulting in a call to view the concept of belonging as complex,
multi-faceted, and impacted by extra-institutional factors [6].

Recent research on sense of belonging among graduate students has begun to consider demographic
attributes and characteristics of the academic environment [7-10]. Gardner et al.’s [8] exploration of
doctoral students’ sense of belonging across different disciplines indicates that engineering doctoral
students reported a relatively lower sense of belonging within their academic department compared to
students in other disciplines. Recent work by O’Meara et al. [11] echo this claim, reporting that fewer
facilitators of sense of belonging exist within STEM doctoral program environments than in non-STEM
programs. These studies point clearly to a need to understand the sense of belonging among engineering
graduate students.

Nationality diversity and lack of interpersonal interactions in engineering

A defining feature of many U.S. doctoral engineering programs is their large proportion of
international students; 40% of all students in doctoral engineering programs are international [12].
According to Weidman’s graduate socialization model [9-10], this diversity in nationality and associated
linguistic and cultural differences can challenge interactions between students of different nations,
including domestic students, which inadvertently affects student’s integration into an academic field or
departmental culture. Studies supporting this theory have found differences in sense of belonging between
domestic and international students [7,11]. Gardner et al. [8] specifically suggested that researchers need to take into consideration the diversity in students’ nationalities, but this has not translated into the literature. However, much of the research on engineering doctoral students instead focuses on diversity in race and ethnicity despite the large population of international students in doctoral engineering students.

Additional challenges in the students’ interpersonal interactions with diverse groups of people (e.g., advisors, faculty, staff, undergraduate students, etc.) in their academic unit can emerge beyond the potential challenges associated with peer interactions suggested by Weidman’s graduate socialization model [9-10]. The advising relationship in engineering was characterized as a supervisor-supervisee relationship where the dominant interaction is focused on academic support [13]. Psychological and social supports, often lacking in engineering doctoral education, play essential roles in building a positive and meaningful relationship between advisors and students [14]. Student’s perceived meaningful connection with their advisor is reported to have a positive impact on their sense of belonging to their program [15], [16]. This strongly suggests the need to consider the lack of interpersonal interactions when investigating doctoral student’s sense of belonging in engineering.

This research explored students’ sense of belonging in the context of engineering doctoral education. Disciplinary specific characteristics, such as diversity in nationality and interpersonal interactions with peer and faculty were considered in an effort to answer two research questions:

1. What contributes to international doctoral students’ perceptions of sense of belonging?
2. What contributes to international doctoral students’ perceptions of positive and negative interactions with their faculty and academic peers?

Research Methods

The primary goal of this study is to understand the critical experiences that influence international doctoral students’ perceptions of their sense of belonging and the quality of social interactions in their academic unit. Given the relatively nascent state of literature focusing on the experiences of international doctoral students in engineering and our interest in understanding the experiences and feelings of people. a constructivist approach was employed [17] using interview-based inductive qualitative methods [18]. Descriptions of participants and participant selection, data collection, and data analysis are provided in the following sections.

Participants and participant selection

International students have a wide variance in experiences depending on their background (e.g., nationality, culture, language, societal structure, and norms for interpersonal distance in social interactions) and demographic characteristics (e.g., gender and marital status) [19] – [23]. Their current residential location (i.e., suburban or metropolitan regions), institutional characteristics (i.e. large public or small private universities), and years of study in the U.S. have also been reported to influence international student experiences due to the diversity in lifestyles, perspectives, and cultures that result from these different settings [24-25]. Variations attributed to characteristics of different engineering PhD programs (e.g., program size, work setting, and international student population) have also been shown to be important factors influencing international students’ experiences. Institution selection for this study was made among
research-intensive institutions because of the robust presence of international STEM graduate students at those universities [26]. This study followed a purposive participant selection process to accommodate for these diverse experiences with a limited number of participants [27].

Eligible participants included international engineering doctoral students currently enrolled in engineering programs at one of four different doctorate granting institutions located in different regions of the U.S: large state school in the southwest (SSW), large state school in the southeast (SSE), small private school in the west (PW), and small private school in the northeast (PNW) (Table 1).

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*The percentage of international student enrollment in each university [28]

Each program’s chair and graduate advisor were contacted by a member of research team to solicit participants. A call for participants containing demographic and background surveys was distributed via various internal listservs. Eligible students meeting the criteria for the study were surveyed to select participants with the most divergent form of experiences based on their background and demographic information. The intention of this process was to maximize the variation within participants selected to participate in this study [27].

A total of 35 eligible participants expressed interest in participating in the study during a four-week recruiting period in October 2018. Two participants from each targeted institution were selected with the goal of diversifying the participants’ demographic backgrounds (e.g., nationality, gender, age, degree program, and years in U.S.) across the sample. The experiences from four of these eight participants will be shared in this paper to provide preliminary findings. Demographic information of selected participants is shown in Table 2. Participant names were replaced with pseudonyms to ensure anonymity and confidentiality. All participants were pursuing their doctoral degree as their first degree in the U.S. The number of years in the U.S represents the number of years in the participants’ program. All participants earned their master’s degree in their home country and directly came to the U.S. except one participant (Farzad) who had been in industry for one year prior to starting his doctoral studies.

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Data Collection

The discovery of significant experiences that influence participants’ sense of belonging and social interactions with peers was facilitated by adopting the critical incident technique (CIT) [29]. CIT is grounded on the perspective that certain interactions or perceptions are critical to understanding resulting behaviors or actions. This approach has been used in higher education to capture the voice of the student and to identify critical incidents related to satisfaction and sense of belonging that may influence their loyalty behavior and professional identity [30].

CIT was employed in this study within a semi-structured interview protocol asking participants to share significant incidents (perceived to be positive and negative based on topic) about the following three topics related to their academic program: 1) sense of belonging, 2) interactions with peers, and 3) interactions with faculty. Participants were asked to share their experiences in as much detail as possible. Prompts from the interviewer to elicit such detail included: “Describe that in more detail for me” and “What is an example of that?” A specific follow-on question was added to the interview protocol after pilot interviews were conducted for participants who indicated that their experiences in graduate school had been impacted by their status as an international student. This additional prompt was: “Think of a time when you feel you were treated differently (either in a positive or negative way) because you are an international student”.

Protocol

One-on-one interviews were arranged for each participant following participant selection and interview protocol development. Participants met with a member of the research team either in a convenient in-person location or through the video conferencing tool, Zoom. At the onset of the interview, participants were reminded of their rights per IRB stipulations and assured that their identity would remain anonymous and the information they provided would remain confidential. The interviews were conducted using the CIT semi-structured interview protocol previously described and each interview lasted between 60 and 90 minutes. A $10 Amazon gift card was provided to each participant after the completion of the interview. Each interview was audio and/or video recorded and transcribed. The interviewer also took an analytic memo during and after each interview.

Data analysis

Data analysis proceeded concurrently with data collection. Data analysis for this study followed qualitative coding methods recommended by Saldaña [31]. The CIT semi-structured interview protocol was
purposely used to gather critical incidents relating to each of the \textit{a priori categories}. The first pass of coding involved structural coding, as a way of highlighting segments of the interview related to specific questions and, subsequently, aligning with the a priori categories of sense of belonging, interactions with peers, and interactions with faculty. For example, the response to the question, “Before the interview, I asked you think of a time when you had a memorable or positive interaction with a faculty member” was coded as [Positive faculty interaction]. Only incidents with outcomes related to the focus of this study were included and coded as part of the study [32-33]. A pattern coding method was then used to increase abstraction. This step required significant interpretation and aimed to develop “meta-codes” [31, pp. 209] and patterns across the data. The codes were iteratively adjusted in the course of the analysis and informed by analytic memos written during data collection and analysis. These “meta-codes” and patterns were reviewed to determine themes across the data. These themes are described below in the findings and discussion section.

The data was approached from more than one perspective to assess trustworthiness and credibility of the analysis. A single researcher coded the interview and was subsequently reviewed by three other researchers who read the interview transcriptions and discussed the initial identified codes and themes. Iterative discussions were undertaken until the four researchers came to a consensus agreement on a list of final themes. Inclusion of positive and negative experiences for each category provided opportunities to identify patterns in the data through a compare and contrast approach.

\section*{Findings}

Themes and subthemes emerged from incidents shared by participants through the coding process as described above. Themes that emerged from the analysis were categorized as academic sense of belonging and sociocultural sense of belonging. The academic sense of belonging category included the emergent themes of academic competency and academic support through interactions, while the sociocultural sense of belonging category included institutional support for cultural transition, lack of comfort reaching out to faculty, unease in being “friends” with peers, and social and cultural “contact points.” Each theme will be described separately in the following sections.

\textbf{Theme 1. Academic competency}

\textit{Academic competency} describes a theme of incidents that contributed to students’ feeling of belongingness to their academic unit (e.g., departments, programs, or labs). It included experiences such as having success with coursework and research, as well as other academically related tasks such as being a Teaching Assistant (TA). An example of this theme was described by Amber when she said that she feels like “I can do this as well as, if not better than, my American peers in academic settings.” One of the most significant experiences described by participants was to have positive feedback from peers and faculty regarding their academic work (e.g., presentations in courses, weekly report in research meetings, or research progress in dissertation meetings). Another experience described that contributed to their academic sense of belonging was to work as a TA and to be able to help engineering undergraduate students in their courses. This specifically included the feeling of confidence and capabilities in teaching engineering content. Of note is that this theme is closely related to the academic support through interactions theme because the students’ academic competencies frequently resulted from interactions with peers and faculty.
theme 2. academic support through interactions

Different types of academic support are needed for addressing different types of academic challenges. *Academic support through interactions* describes a group of incidents that relate to the academic support the students received through interactions with different groups of people (e.g., peers, faculty, or staff in their academic unit). This theme consists of three sub-themes based on the people with whom the students interacted: 1) institutional support for academic transitions, 2) faculty availability and advisor’s research guidance, and 3) academic peer support.

Sub-theme 2.1. Institutional support for academic transitions

Included under *institutional support for academic transitions* were a number of incidents that enabled the students to cope with the issues related to their academic transition. The incidents coded for this theme indicate that this aspect was significant in the students’ early experiences and occurred primarily through positive interactions with first-year advising staff and/or faculty (e.g., graduate coordinators, academic support staff, faculty advisors, etc.). Associated feelings included students being relieved by having people who “really want to help you” and “you can always go and ask questions,” as illustrated by Farzad and Benita respectively. The described roles of academic supports included providing specific resources (e.g., office space or initial faculty advisor assignment) and advocating to mediate academic issues (e.g., academic counseling or coursework-TA workload adjustment). These support sources filled a void not yet filled by a faculty advisor for most students during their first year in their respective doctoral programs.

Institutional differences emerged between the incidents collected from the participants at private and public universities. Differences included the perceived approachability between the students and first-year advising staff or faculty and closer relationships with more frequent interactions for students at small private institutions. Benita explained, “Here in my university, a lot of people just go and ask questions in person, because it’s a small university…many people are in two or three doors away.” This implies that the potential variances in the perceived belongingness among students with similar resources depend on institution and program size [34]. The subsequent differences in physical distances between people and the number of students advised by an individual advising staff or faculty impacts the perceptions of the students.

Sub-theme 2.2 Faculty availability and research guidance

*Faculty availability and research guidance* contains a group of incidents that related to positive interactions with faculty, including instructors and the student’s advisor. This theme included faculty providing extra support as instructors outside of the classroom (e.g., holding office hours, providing digital versions of class materials, suggesting supplementary resources) and displaying a patient attitude that encouraged students, particularly in the presence of language barriers.

A high number of incidents among the perceived quality interactions with advisors were coded in this category, which indicate an impact of advisor’s academic support being perceived by students as impacting their sense of belonging. Particularly dominant experiences included the advisors’ interest, guidance, and positive feedback on the students’ research. This was illustrated as a result of student perceived academic competency (see Theme 1). These results suggest the potential influence of advisor relationships on the students’ perceived belongingness, but are framed by the caveat that students also recognized a lack of availability or uneasiness in reaching out to advisors as illustrated by Benita when she said, “I understand, but they are busy”.

6
Sub-theme 2.3. Academic peer support

Academic peer support describes a group of incidents relating to the students’ interaction with peers that contributed to the students’ feeling of being connected. These incidents included experiences and feelings involved with having peers to work with, feeling comfort in asking questions, sharing common academic concerns or research ideas, and sharing physical work spaces. This only includes interactions with the peers within the students’ academic units. As Benita described, “I can have friends anywhere, but hanging out with the friends outside of [the] program doesn’t influence my feeling of belong[ing] in the program”. One of the most significant aspects of this sub-theme was that the majority of peers described academic peer support as coming from other international students, not from their domestic student peers. This was described by Amber when she explained, “American peers may have their own study groups”. Students also cited challenges in initiating interactions with peers, which included negative experiences when trying to connect with peers.

Theme 3. Institutional support for sociocultural transition

Institutional support for sociocultural transition described a group of incidents relating to the social and cultural supports that the students received from their institutions (e.g., international student, administrative, or housing offices). Most of the incidents coded for the support from institutions occurred in the formal programs provided by the institutions (e.g., international student orientation, assistance with administrative work such as Visas, SSN, housing, etc.) during the students’ transition to the U.S., which coincided with the beginning of their doctoral studies. The supports included provided cultural and living information that created opportunities for socialization among international students. Participants attributed those incidents to feelings of less frustration about dealing with all the requirements needed for such a life transition by international students who “don’t know how things work at all because we are not used to liv[ing] here”.

Theme 4. Faculty Psychosocial Support and Lack of comfort reaching out to faculty

The incidents for this theme included any faculty-initiated conversations about the students’ cultural background or current issues in their home country. These incidents included any advisor inquiries relating to a student’s status as an international student (e.g., Visa status, visits home during breaks, etc.). One of the significant aspects of those incidents was the students’ feeling of being understood about the status of being an international student, which positively contributed to their feeling of attachment. Such conversations also played a role in helping students become comfortable with their advisor. Benita explained, “She's my advisor and I wasn't somehow expecting that [her advisor asking about her Visa status], so I felt really nice. I felt like she's just a kind of person that I can go and say [ask for help] and she would understand”.

The described incidents imply that students felt cared for by the faculty because of perceived considerations displayed during their interactions. Additional incidents relating to a perceived hierarchical culture [35] showed that they felt anxiety or pressure associated with initiating interactions (e.g., asking questions or sharing concerns) or interacting in a one-on-one situation [36-37]. Amber described, “Well, for right now, about most of my interaction with my advisor, even though in lunch conversations, it's still stressing me out like. I feel uncomfortable…Just, I’ve never felt comfortable in the interactions with people having power over me.” This statement highlights how diverse cultural aspects, such as societal structure and language differences, can play a role within student-faculty interactions. Similar interaction patterns of
students’ feeling of uneasiness to approach faculty in Sub-Theme 2.2 emerged during student-faculty interactions regardless of the types of interactions.

Another feature within this theme was that most of the incidents relating to the advisor’s psychological supports for personal issues (e.g. holiday invitation, informal conversation in lunch, questions about how a student was feeling, etc.) were regarded as not necessarily contributing to the students’ belongingness to their academic unit; however, they were regarded as meaningful interactions with advisors. Students did not perceive such psychological and emotional support as the responsibilities of their advisors, as Farzad mentioned, “I understand what support is, so I'm not looking for beautiful words from [my advisor]”. This contributes to the impact of student expectations on their perceived quality of interactions and reflects the previously reported limited interactions with advisors [13].

**Theme 5. Unease being “friends” with peers**

This theme includes student perceived challenges in socialization that result in a lower possibility of being socially accepted and included in a community, i.e., feeling or lacking a feeling of connectedness. A high number of incidents relating to students’ sense of belonging were about the difficulties they had faced in socialization. Those incidents mostly occurred in the interactions with domestic peers. An example was not being able to join a conversation with groups of peers, as Benita described, “The language is a barrier…There are some jokes [in the conversation] and sometimes you are like ‘what?’ because you don’t get it, you know. You somehow feel excluded because you don’t understand everything said”. There is a desire by international students to be included with both their domestic and international peers during daily interactions, as Farzad mentioned, “I think international students here are likely to hang out with their own countries’ classmates, but I’d like to hang out with everybody as a whole [group]”. Both incidents contain aspects of feeling excluded as they were physically and psychologically isolated from group talks. Amber describes this as, “You know, you sat there quietly and felt really uncomfortable. Then it really shows that you are not belonged, as opposed to you're having lunch with them and you totally are their friends”. The commonly perceived reason mentioned by the participants was the presence of cultural differences including language, norms in verbal interactions, and an empty set of common interests outside of research. Students’ unfamiliarity with the culture of socialization itself also emerged as described by Amber, “I feel like compare to my experiences in Taiwan, people here talk to strangers who are considered as acquaintances in Taiwan”. Overall, it is worth noting that most incidents relating to the students’ peer interactions negatively attributed to their sense of belonging unlike those linked to academic sense of belonging. The one exception was when a private invitation was made by domestic peers.

Another group of incidents significant in this theme included the students’ doubts to become “friends” with domestic peers. This negatively influenced students’ feeling of being accepted or included. The repeated experiences of failing to join socialization experiences showed a negative influence on the student’s perceived possibility of having an affinity with domestic students. According to Amber, “People here are like, trying to be polite in anything. But, politeness is not enough to become friends or want to become friends”. A significant underlying aspect across these incidents was students’ previous or current willingness to become close friends with domestic students as well as efforts to join socialization experiences (e.g., practicing English, trying to speak up in public, watching TV to learn the culture). Amber continued by saying, “But, for me, I really want to blend in. And whenever I have a good social interaction or a good conversation with [one of my domestic peers] then I truly feel like, oh I can really belong too someday”.

8
**Theme 6. Social and cultural “contact points”**

A high number of negatively perceived incidents relating to the students’ interactions with peers emerged in Theme 5, but not all peer interactions within this theme were viewed as negative. Positive incidents grouped in this theme were most often related to the students’ interactions with domestic peers, but also included those with international students. A high number of incidents described moments when, for example, peers showed an interest in their culture, intercultural friendships existed, and experiences relating to the students’ cultural backgrounds were shared. A major aspect across these features was that the students found cultural “contact points” that they could build conversations around, which was explained as shared interest in aspects of culture. This enabled them to have positive expectations to overcome the identified challenges in peer interactions as described in Theme 5. Although these moments of finding contact points for social interactions with peers were pointed out as positive and meaningful incidents, they were not regarded to have impact on their social sense of belonging. This implies an insufficient depth of such interactions from a student’s perspective.

**Discussion and Conclusion**

This study is a preliminary exploration of the concept of ‘sense of belonging’ from the perspective of international engineering doctoral students. Efforts were made to take disciplinary specific characteristics (i.e., diversity in nationality and limited peer and faculty interaction) into account in the process of developing a research methodology. Emergent critical incidents distilled from the participants’ lived experiences enabled an in-depth understanding about sense of belonging and the dynamics of interactions among different groups of people with different cultural backgrounds.

Our findings included six emergent themes relating to the students’ interactions under academic and sociocultural sense of belonging supported by critical incidents or significant aspects of the themes. This analysis within the context of engineering resulted in two dimensions of sense of belonging – academic and sociocultural integration – suggesting the need to consider cultural aspects in addition to the previously reported academic and social aspects. The added cultural component supports Weidman’s graduate socialization model [9-10], which argues the need to consider individual interactions. Also, a high number of critical incidents relating to the students’ interactions with staff suggests a need to expand analysis of interactions that attribute to students’ belongingness in this specific context beyond faculty advisors and peers.

Analysis across the themes resulted in patterns explaining the influence of students’ interactions with faculty on how they perceived their belongingness academically and socially. Our data suggests that the students’ feeling of academic belongingness was largely influenced by their interactions with faculty, primarily their advisors. A dichotomous view of faculty interactions appeared relating to the psychological support provided through faculty interactions. The majority of incidents of meaningful faculty interactions were relating to the advisors’ psychological or social support, even though students perceived such interactions not necessarily as their advisors’ responsibility. Additionally, the need to consider students’ cultural backgrounds emerged as some incidents showed how the hierarchical culture of students’ home countries influenced their current interaction with faculty by generating uneasiness to initiate an interaction [35-36].

Different patterns emerged relating to the influence of students’ interactions with peers on their academic and social belongingness. The lack of interactions with peers, mainly referring to their domestic peers, led students to feel socially unaccepted or unconnected to the program. This finding was in clear contrast to the results pertaining to faculty interactions. One of the significant aspects of peer relationships
was participants’ desire to be seen and authentically related to as an individual instead of an international student [38-39]. This finding aligns with Baumeister and Leary [34] seminal article where the need for belongingness was defined as more than superficial social contacts, but those within the context of desired relationships with ongoing and stable features. Specific incidents also revealed the aspects of socialization that hindered smoother interactions, which contribute to defining the problem that further social supports are needed.

These preliminary findings serve as an important first step toward better understanding the multifaceted concept of ‘sense of belonging’ in the context of doctoral engineering education. The identified incidents with detailed examples will contribute to uncovering hurdles and identifying where supports are needed for students’ academic and social integration. This will guide the development of support structures for these and many other students.
References


