Psychological Sense of Community & Belonging in Engineering Education

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Abstract - Using previously validated measures, belonging and psychological sense of community are measured in a cross section of engineering communities including engineering classes at the sophomore and junior level at a major Research 1 University and various conference venues and research center retreats. Belonging and sense of community vary among the venues examined. As students become more invested in their community of practice (moving from undergraduate to graduate level), belongingness and psychological sense of community (PSC) increase. Differences in belonging and PSC also occur within different groups of graduate students but remain surprisingly consistent among undergraduates. Both of these affective/relational measures are important to academic outcomes and student experience as they mediate academic engagement and are mediated by extraversion, making it more difficult for the introvert-dominated engineering student population to attain strong connections to community.

Index Terms – Belonging, Psychological Sense of Community, Affective Measures, Academic Engagement

RELEVANCE

The success of any instructional style in promoting meaningful learning, whether novel or traditional, active or passive, is critically dependent on the engagement of students in the course of instruction. Improving engagement, whether explicitly or implicitly, is a central goal of effective pedagogy. Sense of community, belonging, and related measures have been clearly linked to academic engagement and performance in K-12 communities. Sense of community is moderated by extraversion [2]; since engineering is dominated by introverts [3] as defined by the Myers Briggs Personality Type Scale (MBTI), particular emphasis toward the healthy development of belonging and PSC may be influential in the affective contribution to positive academic outcomes and engagement.

The literature, gathered from higher education, K-12, and organizational psychology clearly supports the importance of relational community in influencing engagement and cognitive outcomes and performance. Belonging and other connections to community are known and significant contributions to engagement in K-12 education [4][5][6]. A greater sense of connection to community, ranging from the immediate (belonging) to the broad (affiliation) level can also enhance retention, thereby delivering greater numbers of engineers to the technical workforce. Belonging and membership in the school community are proven to influence drop out rates in the K-12 community [7] and also affect higher education that cites lack of community (isolation) as a primary reason for women connections that people develop with others in the communities in which they live, work, and play. Of these constructs, belonging is the most fundamental, believed to be a basic human motivation [1]; belonging reflects the stable and consistent relational bonds that a person experiences in his everyday life in his proximate communities. All persons seek to satisfy the need to belong and a lack of belonging can lead to sub-optimal (compensating) behaviors and negative academic and social outcomes. Belonging can lay the foundation for stronger sense of connection to other, surrounding communities, including the larger organizations in which someone participates and is affiliated. In this study, belonging is investigated in a cross-section of academic communities in higher education, ranging from research conferences to retreats to the classroom itself. Fundamental perceptions of belonging are studied relative to connections to the surrounding home institution (Psychological Sense of Community or PSC) for each study participant.

INTRODUCTION

As a fundamental human motivation, belonging is important in any endeavor, whether academic, commercial, or otherwise. In engineering education, belonging may be especially important in the study of academic outcomes, because belonging and psychological sense of community (PSC) are moderated by extraversion [2]; since engineering is dominated by introverts [3] as defined by the Myers Briggs Personality Type Scale (MBTI), particular emphasis toward the healthy development of belonging and PSC may be influential in the affective contribution to positive academic outcomes and engagement.

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DEFINITION OF TERMS

Belonging, belongingness, psychological sense of community, and affiliation are all constructs that speak to the relational aspects of the individuals within a community. The concept of belonging refers to the stable and consistent relational bonds that a person experiences in their everyday life in their proximate communities. Belonging reflects the fundamental human motivation to feel connected to others and to be part of a larger social network. The psychological sense of community (PSC) is a measure of how individuals perceive their connection to a particular community, including their sense of belonging, shared norms, and common purpose. Affiliation refers to the number and type of connections an individual has within a community, including both formal and informal relationships. These constructs are important in understanding the affective and relational aspects of academic outcomes and student experience in engineering education.
to leave engineering fields [8] and connection to faculty community as a strong contributor to Hispanic student persistence in academic endeavors [9]. Improvements in retention resulting from increases in connection to community are also supported by the higher education model of social integration developed by Tinto, where student goals and commitments formed by pre-college attributes interact with their college experiences to indicate whether students are likely to complete an academic program [10]-[12].

Thus, from a variety of perspectives and theoretical frameworks, belonging and psychological sense of community (PSC) are important contributions and often mediators of academic engagement and academic achievement. As a preliminary study among engineering students on the importance of these affective/relational measures on the student experience, two basic questions are addressed herein: (a) What types of communities exhibit significant differences in participant belonging? and (b) Does belonging increase as participation in a community advances from peripheral (undergraduate) to central?

**Methods**

This study has adapted items from instruments used to assess belonging in the Girls Clubs of America; all items were validated in the higher education contexts under investigation before being aggregated and used to understand belonging in all the source populations. All populations were self-selected (voluntary) and contained different combinations of faculty, undergraduate, and graduate student populations.

**Survey**

Respondents are asked to evaluate their sense of belonging in the immediate context (the event/location in which the survey is administered) and their related sense of community in the surrounding context of the home institution (PSC). Due to a lack of belonging studies at the higher education level, all items are previously validated items from the Anderson-Butcher belonging scale [13] used to assess sense of community within the Girls Clubs of America. These items were re-validated in this study to ensure that they measure the belonging constructs of interest. A complete list of survey items (used to assess belonging and PSC) is listed in Table 1 for clarity. The list consists of a subset of Anderson-Butcher belonging scale items that, using an exploratory factor analysis, strongly reflected belonging (and sense of community) in the higher education setting. Additional items that did not load well onto the belonging or PSC construct were assessed as separate constructs or individual single factors for analysis. All items were assessed on a 5 point Likert scale.

**TABLE 1: SURVEY ITEMS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Immediate Context (Belonging)</th>
<th>Surrounding Context (PSC)</th>
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<tbody>
<tr>
<td>1</td>
<td>I feel comfortable in the conference/retreat/class.</td>
<td>I feel comfortable with faculty at my home institution.</td>
</tr>
<tr>
<td>2</td>
<td>I feel part of the conference/retreat/class.</td>
<td>I feel part of my home institution.</td>
</tr>
<tr>
<td>3</td>
<td>I feel supported at the conference/retreat/class.</td>
<td>I feel supported by faculty at my home institution.</td>
</tr>
<tr>
<td>4</td>
<td>I feel committed to the conference/retreat/class.</td>
<td>I feel committed to faculty at my home institution.</td>
</tr>
<tr>
<td>5</td>
<td>I feel supported by students at my home institution.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I feel committed to students at my home institution.</td>
<td></td>
</tr>
</tbody>
</table>

The belonging survey has been administered to six different populations consisting of various combinations of graduate students, and undergraduate students. No participants were part of more than one of the six populations (i.e. the populations are non-overlapping). The six populations, the number of participants in the survey n and the total possible number of participants N (estimated) in each location are:

- Engineering Research Conference (EngConf): a venue for faculty and graduate students to present research results in sensors research. Graduate students are the majority of the conference population but faculty are also present. Survey participants are self-selected from randomly chosen sessions (n = 29; N = 4000).
- Engineering Research Center Retreat (Retreat 1): a venue for faculty and graduate students participating in NSF-sponsored research centers with a topical focus in an important, contemporary aspect of engineering research. Graduate students are the majority of the retreat population, but faculty and undergraduate students are also present. All participants are affiliated with one of several highly focused engineering research centers around the country. Survey participants are self-selected from a student-only, professional development workshop at the retreat (n = 32; N = 200).
- Science and Technology Center Retreat (Retreat 2): a
venue for faculty and graduate students participating in NSF-sponsored research centers with a topical focus in an important, contemporary aspect of scientific research. Graduate students are the majority of the retreat population, but faculty and undergraduate students are also present. All participants are affiliated with a representative science and technology center (which includes four participating higher education institutions). Survey participants are self-selected from a student-only, professional development workshop at the retreat (n = 51; N = 200).

- R1 sophomore classroom (R1 Sophomore): an introductory class for undergraduate students in electrical engineering at a major Research 1 university. Survey participants are self-selected from the class (n = 42; N = 42).
- R1 junior classroom (R1 Junior): a junior level core class for undergraduate students in electrical engineering from the same Research 1 university as R1 sophomore. Survey participants are self-selected from the randomly chosen core class (n = 36; N = 55).

**RESULTS**

Belonging and PSC in all five populations investigated in this study have been aggregated in Table 2. The Retreat 1 population demonstrated the highest combined connection to community while the R1 classrooms demonstrated the lowest connections to community (combined PSC and belonging). Significant differences were found in belonging between Retreat 1 and Retreat 2 (p = .0305; F = 4.85) and between Retreat 1 and the R1 Junior Classroom (p = .0065 and F = 7.9). The R1 Junior and R1 Sophomore populations were so similar in their responses that additional assessments of the classroom populations were made only for the R1 Junior population.

<table>
<thead>
<tr>
<th>Population</th>
<th>Belonging</th>
<th>PSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>EngConf</td>
<td>3.88</td>
<td>4.35</td>
</tr>
<tr>
<td>Retreat 1</td>
<td>4.14</td>
<td>4.32</td>
</tr>
<tr>
<td>Retreat 2</td>
<td>3.73</td>
<td>3.40</td>
</tr>
<tr>
<td>R1 Junior</td>
<td>3.70</td>
<td>3.49</td>
</tr>
<tr>
<td>R1 Sophomore</td>
<td>3.67</td>
<td>3.44</td>
</tr>
</tbody>
</table>

Several significant differences in belonging occur for the various communities studied in this effort (Figure 1). At some level, all of these communities seek transformational change whether through a conference, a classroom, or a research center; this emphasis on transformational change is clearly reflected in the mission or over-arching top-level description of each community. For example, the first research center evaluated (Retreat 1) was institutionally framed to engage “... transformational engineered systems research in order to advance technology and produce engineering graduates who will be creative innovators in a global economy.” [14]. Similarly, the second research center (Retreat 2) is framed to conduct “… world-class research in partnerships ... to create new and meaningful knowledge of significant benefit to society” [15].

Despite the emphasis on community, profound change, and the link between the two, belonging indicators in these two groups are significantly different (4.14 vs. 3.73 on a 5 point Likert scale for the Retreat 1 and Retreat 2 populations respectively; p = .03); this difference indicates a substantial difference in the relational fabric of the community, likely heavily influenced by leadership and management strategy. In fact, the Retreat 2 scores are comparable to the classroom (R1 sophomore and R1 junior) scores, indicating that community building (initiated by the research center as compared to the classroom itself) has not permeated Retreat 2 sufficiently to impact belonging.

The results of this study also strongly indicate that a sense of belonging at the local (immediate context) transfers to a greater sense of community (PSC) in a surrounding context, at the home institution (Figure 2). Belonging has been demonstrated, in a comprehensive examination by Baumeister & Leary (1995), to be a fundamental human motivation, a basic need without which other social connections (and other psychological needs) cannot be attained. Psychological sense of community is similar to belonging but not fundamental to human need as it relates to the sense of connection to a larger institution [2]. The fundamental nature of belonging suggests that anyone who experiences strong relational connection to the immediate (proximal) community will likely have the
fundamental attachments necessary to develop a greater sense of connection to larger communities in which the individual participates or is affiliated. Where the sense of belonging in the classroom, conference, retreat is high, so the sense of belonging (connection to the home institution community) is also high. This relationship is demonstrated in the Retreat 1 population (belonging of 4.14 at the retreat and 4.32 at the home institution). However, the reverse is not necessarily true. When belonging (sense of connection to the home institution) is high, it does not universally translate to a strong sense of belonging in the conference, retreat, or classroom. For example, the sense of belonging for the R1 sophomore population in the classroom is moderate (3.7) while the corresponding sense of connection to the home institution (broader context of belonging) is low (3.49). In contrast, the Eng Conf population demonstrated a moderate sense of belonging at the conference itself (3.88) but a much higher sense of connection and belongingness to the home institution (suggesting that the need to belong is being met in some other way than through the research conference). In summary, the results of this study indicate that belonging correlates to PSC, thereby strengthening the likelihood that belonging, as the Baumeister & Leary analysis concludes, is a fundamental human need.

CONCLUDING REMARKS

In a substantial amount of studies in K-12, belonging has proven to be an important contributor to academic achievement and engagement. However, in higher education, belonging has not been studied, except in a broader sense, as a connection to the student’s primary institution (psychological sense of community). This study has established a baseline for belonging in a cross section of engineering education communities ranging from undergraduate classes to graduate retreats/conferences. Belonging and PSC increase as an engineering becomes more central and less peripheral to the community, (advancing from undergraduate to graduate status) Students also appear to respond to community building efforts, by showing a corresponding increase in belonging. Thus, despite the fact that relatedness, belongingness, and connection to community are counter-moderated by introversion, belonging can still be improved in introvert dominated engineering community via external instructional and community effort. The benefits of increased belonging already evident in K-12 are likely achievable in the engineering education community. Increased belonging can not only improve immediate academic outcomes and engagement but can also support the continued growth and expansion of much needed active instruction techniques (as compared to passive, lecture based instruction).

REFERENCES