A Shift to Praxis: Towards a More Inclusive Research Agenda about Belonging in Computer Science

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ABSTRACT

Studies of computing student belonging have proliferated in recent years. A theme in the work has been quantitative efforts to measure belonging in a way that is generalizable across contexts, and emphasized differences in demographic groups' perceptions of belonging, with groups underrepresented in computing often coming up short by comparison. In this perspective on equity piece, the author suggests rich, contextual studies of belonging may unearth the complexities of these dynamic perceptions that students hold. Similarly, expanding the sites of student research participation beyond large elite institutions to include majority-minority institutions could complicate the notion of belonging and "fitting-in." Alternative research agendas that center praxis in computer science belonging may improve efforts of inclusion, and provide useable knowledge about whether and how students come to belong in the field.

CCS CONCEPTS

Professional topics- Computing education - Computing education programs- Computer science education

KEYWORDS

belonging, diversity and inclusion, higher education, qualitative methods, praxis

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1 INTRODUCTION

Studies of computing student belonging have proliferated in recent years. A Google Scholar search from 2019 to the present retrieved over 20,000 papers with the search terms "computer science", "belonging", and "undergraduate", and a search in the ACM digital library search with the terms returned over 5,000 pieces from 2015 to the present. A theme in the work has been quantitative efforts to measure belonging in a way that is generalizable across contexts, and emphasizes differences in demographic groups' perceptions of belonging, with underrepresented groups often coming up short by comparison. In this perspective on equity piece, I suggest that quantitative, correlational belonging research has hampered our greater understanding of what it means to belong in computer science learning environments because it essentializes demographic differences in belonging measurement. I propose the use of rich, contextual qualitative studies of belonging, which may unearth the complexities of students' dynamic perceptions. Similarly, expanding the sites of student research participation beyond large elite institutions to include smaller and majority-minority institutions may help complicate the notion of belonging and "fitting-in."

In this equity perspectives piece, I propose a shift to praxis, or the combination of action, theory, and reflection [1]. I describe patterns evident in belonging research in computer science education research, explore complications with the status quo (particularly in relation to broadening participation), and suggest how approaches from other social science fields (such as anthropology and/or social design) might better support efforts to improve student perceptions of belonging in their courses, CS departments, career pathways, and future computer science education pursuits. At present, much of the research seems focused on measuring belonging and is less focused on identifying and recommending actions to improve student belonging. I describe this research agenda of praxis to create CS education researcher agency towards more inclusive perceptions of belonging among computer science learners and to move towards organizational change within computer science higher education.

2 CONSIDERATIONS FOR POSITIVIST BELONGING RESEARCH

Like much discipline-based educational research, computer science education research draws heavily from positivist, psychological perspectives of teaching and learning from a cognitive perspective [2, 3]. Positivist psychological research

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emphasizes the individual learner over the environment of learning and values statistical reliability and validity as measures of quality in investigations. Evidence is generalizable and replicable, and outliers can be neutralized with bootstrapping maneuvers that account for statistical noise.

Positivist psychological methods in education tend towards the correlational, though course-level or program-wide higher education improvements may involve studies that are experimental in nature. Specific examples can be found in computer science (CS) education research in the study of pair programming [4], use of peer led team learning [5], and flipped classroom studies [6], in which course grades are the dependent variable and shifts in achievement are predicted with improved teaching.

In contrast with positivist psychology-based research paradigms, praxis involves theory, reflection, and research as doing. Praxis as a research method most closely mirrors what Schön called "reflection in action" [7]. Praxis is reflective, dynamic, and involves engagement with the practice of educational research and teaching.

In this piece, I contend that while the application of positivist research methods to experimental, achievement-focused research questions may support our understanding of computer science education, the application of positivist perspectives to the notion of belonging has been less effective. In the following sections, I detail this argument based on the body of literature with quantitative, correlational arguments about belonging, with an emphasis on issues of equity, as applicable.

2.1 CS belonging research variously defines belonging

Belonging is a social construct that has everyday meaning. One may feel as if they fit in or feel they are comfortable being themselves in a given community. The ways that belonging has been defined has varied across the computer science education research literature. In some cases, a "sense of belonging" is described in a colloquial way with little connection to theoretical framing [8]. Other studies employ multiple aspects of belonging in their work. For example, Mayfield et al. [9] utilize a multi-faceted definition of belonging involving membership, affect, acceptance (or lack of acceptance, trust, and a lack of desire) to fade from a study of women in math [10] The subjectivity of one's perception of belonging is addressed by Nguyen [11], as well as belonging as a need to feel legitimate in the discipline in question.

2.2 CS belonging research varies in depth of measurement

Survey research employing the "belonging" concept has varied by the extent to which it measures the construct or latent variable. Often, recent quantitative studies in computer science education research use one to three Likert items on a survey. Construct development has not been common in the work, as other scales are adapted for the purposes of studying belonging in CS, yet processes exist for the development of high quality, robust survey scales [12] that might provide greater nuance and specificity regarding student perceptions of belonging in CS.

2.3 CS belonging research includes ill-defined sites for belonging or belonging referents

Quantitative studies of belonging in CS educational research vary by the extent to which they operationalize belonging to a specific computing community, experience, workplace, or learning context. In other words, the studies lack clarity regarding what the participant perceives they belong *to* or *in*. Investigation of the item wording can in some cases clarify the intended referents—items reviewed for this perspective piece utilize the term "computing" as the referent, perhaps to denote the field as a whole, while others specified individual courses for the site of belonging. It is unclear whether additional information is provided to survey participants, or if the referent appears vague to the respondent as well. This lack of specificity within a survey means that respondents are, essentially, answering different questions. It also means that comparing different research studies may not be all that useful, given that the different studies are embedded with different assumptions about to what students belong.

2.4 CS belonging research lacks dynamism

Large scale studies of computer science student belonging are typically snapshots of participants' perceptions in a point in time and in a particular narrow context (e.g., a course) or in a broad, discipline-wide way (e.g., computing as a field). See Krause-Levy [13] and Lishinski [14] for exceptions, wherein the authors measure belonging at multiple timepoints. Similarly, participants are not often asked to describe changes in their feelings of belonging or to convey when, where, and how they feel like they *do* belong in computer science, compared with when, where, and how they feel like they *do not* belong. Like any aspect of identity, belonging is a concept that could be viewed as dialectic, or changeable in interaction and varied in situ [15]. Educators who aim to improve inclusivity would do well to understand the dynamic nature of belonging and replicate contexts, experiences, and engagements that boost a sense of belonging in CS learners.

2.5 CS belonging research seeks to quantify differences in perceptions

Positivist, quantitative social science research seeks categorical difference that is generalizable across populations. Investigators often divvy up participants and who they are into categories that are pre-defined, easy to abstract, and readily available in institutional records: GPAs, gender, ethnicity and race (as defined by an institution), and prior achievement. In this way, contextual differences are muted, rather than explored in depth, even when experiences are acknowledged as shaping belonging [16]. Categories of difference for exploration, however, can be viewed as characteristics or identities that lie within an individual. Attending to intersectional differences as a means to quantify and generalize difference can *simplify rather than amplify* the complexities of race, ethnicity, gender, ability, and achievement [17]. Correlational studies do seek to connect high perceptions of

belonging to specific background characteristics, yet these findings can be conflated, as they may point to unequal opportunities, such as less demanding K12 educational experiences, as barriers to belonging.

2.6 Published CS belonging research occurs in well-resourced universities

A review of ICER or SIGCSE proceedings shows the disproportionate number of studies authored by faculty in high-resource, R1 institutions. At regional, teaching, or minority serving institutions, funding and dedicated time to complete research in CS education is a less common luxury. A recent search of NSF awards with the key terms "computer science education research" and "undergraduate" show disproportionate representation of R1 and predominantly white institutions (PWIs). While researchers may involve institutions beyond their own, particularly for large-scale studies, the norm in discipline-based educational research is for the body of knowledge to be built in contexts where student populations are predominantly white and privileged [18].

3 POSITIONALITY STATEMENT

I am a cisgender white female second-generation college graduate from the Midwestern United States. I am a trained educator with a Ph.D. in the learning sciences from an R1 institution and a background in K12 preschool, bilingual, and special education. My professional work has encompassed social science research and, more often, program evaluation in the realm of broadening participation in STEM, with a particular emphasis on studying minority-serving institutions. When acting as an evaluator, I view my role as conducting applied and design-based research to recognize promising practices in equitable STEM learning environments and to understand how learning environments shape student achievement, identification, and belonging. With this lens, I propose a Belonging Praxis Research Agenda that shifts focus from individuals towards systems, from deficiencies in learners to deficiencies in environments, and from dissection of student characteristics to dissection of effective belonging contexts.

3.1 Possibilities in CS belonging research

Praxis is defined as "action that is morally-committed, and oriented and informed by traditions in a field"- a stance of value in Diversity, Equity, and Inclusion (DEI) education research. Educational research traditions of instructional design, action research, ethnography, applied mixed methods, and social design research provide opportunities for reflective action as well as reasoned knowledge production, which could be supportive in understanding student belonging while we as educators move towards improving and expanding who belongs in CS, and how they connect to the field.

3.2 Consider studying learning environments with an emphasis on contexts where all students thrive

Educational research works highlighting promising practices to promote belonging can help the field of CS belonging research grow while supporting inclusion and organizational change. For example, Rivera and Nunez [18] describe how staff at HSIs can be integral in creating positive learning climates in CS departments. Work that investigates site-specific issues of *not* belonging can also support the field's understanding of belonging—the problem definition approach by Amari Lewis [19] to uncover why minoritized student populations were leaving the major at an R1 can be an initial step in praxis work to promote inclusion in CS.

3.3 Honor student-defined meaning making regarding belonging

Correlational quantitative studies of belonging differences have in some cases created binaries to investigate belonging as an either/or proposition. However, understanding the complexities of belonging may better position CS stakeholders to make changes at the organizational level to support greater sense of belonging across a greater swath of students. Self-defined perceptions of belonging through the navigation of one or multiple sites of CS learning and practice honors the meaning-making in which individuals engage in social spaces. The work of Winter and colleagues [20] provides an example of young women in the UK navigating their fit in early CS coursework. Lewis [21] studied students' negotiations of their affiliation with common CS stereotypes, and the authors documented their acceptance or rejection of those stereotypes in their navigation of belonging. Similarly, Rankin [17] uncovered complexities of belonging and not belonging of women in computing across multiple learning and workplace cultures in CS. Acknowledging student perceptions and meaning making regarding belonging can support our knowledge of the concept in CS spaces.

3.4 Seek factors that support improved, positive perceptions of belonging

Studies can support understanding of belonging through their promotion of specific actions or activities that evidence suggests boosts sense of belonging in CS, such as Wright and Tamer's [22] finding in a large scale comparison of students who had or had not attended a conference in their field in their first or second year of CS study. Their analysis suggests conference attendance is a marker for higher sense of belonging in the field. In the same vein, Kargarmoakhar [23] and colleagues demonstrated differential belonging in students participating in a community program, when compared to a matched sample of peers who did not participate in the program. Creating a body of evidence for departmental action (e.g., funding conference participation, supporting preparation for student conference attendance, and/or creating mentorship structures for students) will suggest courses of action that organizations can employ to support positive CS departmental climates.

3.5 Define the referent for belonging, and consider scoping studies that can promote local action

Sociological efforts that indicate how societal biases influence belonging for groups minoritized in CS are vital for making the case for institutional and cultural change. The scope, however, of such studies make movement towards change daunting—praxis of belonging work situated in localized contexts can leverage sociological arguments to operationalize actively challenging stereotypes through documented, measurable action. Defining belonging in our work to spaces where we might exert change (e.g., departments, courses, extracurricular efforts) such as Mayfield and colleagues did at the course level [9] is valuable for assessing changes in belonging within CS educators' realms of influence.

3.6 Reconceptualize rigor in belonging research to include dynamic, community-focused, design based research

The notion of rigor in computer science research more generally places CS *education* research at the margins [24, 25]—the prioritization of quantitative studies in CS educational research, then, [26] may be a reaction to this marginalization. However, if goals of DEI are to be realized, active participation in making organizational change is necessary. A turn towards critical theory in CS educational research [27] could support efforts to improve belonging, and acceptance of multiple ways of knowing by the CS education research community can expand what we know about student success.

4. LIMITATIONS AND ASSUMPTIONS

This perspective piece does not reflect a systematic literature review, rather a holistic impression of a CS subfield that conducts research in multiple venues, with differing definitions of what counts as research and what counts as knowledge about teaching and learning. The perspective of the author is based on their perceptions of the ethos of the belonging work to date. It is not comprehensive of all work in belonging in CS. In future work, the author intends to analyze higher education computer science belonging literature along learning theory and problem posing features of the research efforts.

4.1An in-progress approach to belonging praxis

In a related social science effort, I collaborated with computer science department staff to develop counternarratives, stories that highlight attitudes and behaviors of non-dominant groups as they navigate identity development [28]. The counternarratives are of LatinX students who are completing their undergraduate degrees in the computer science major at a regional Hispanic Serving Institution that is aspiring to improve its research status. The narratives are developed from multiple interviews given over time, and are enhanced by the staff knowledge of individual student experiences highlighted in the short pieces. The counternarratives are brief, and contain impressions of faculty and staff engagement, as well as how the differing types of relationships with staff, most of whom share elements of their heritage, and faculty, most of whom do not, shape their sense of belonging in the computer science department as well as their belonging in the field in general. The goal of the development of counternarratives is to share the stories as a professional development activity, primarily with small groups of faculty engaged in equity efforts, to start conversations about policy and practice changes needed in the department.

5. IMPLICATIONS AND NEXT STEPS

Alternative research agendas that center praxis in computer science belonging may improve efforts of inclusion, and provide useable knowledge about whether and how students come to belong in the field. Expansive definitions of rigorous, valued research approaches that are oriented towards inclusion and action through organizational change can help the field transform CS higher education learning spaces into those in which everyone can belong.

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