

Applying an Integrative Belonging Framework to Explore Students' Perspectives at HSI

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Abstract

The concept of belonging is ubiquitous in recent literature about undergraduate engineering and computer science recruitment and retention, yet conceptualizations of the construct can be ill-defined. While quantitative, survey-based efforts can show correlations between a students' self-described belonging and other variables, qualitative studies are necessary to learn how and why students develop a sense of belonging in their discipline. In our study, we focus on one interview item related to departmental fit, and we categorize the complex ways students perceived their own belonging, or lack of belonging. This study adopts a comprehensive framework based on the work of Allen and colleagues [1] for considering belonging and applies the framework to interviews focused on student belonging to their academic department. As students described whether or not they felt they belonged to their academic department, they described what contextual factors supported feelings of belonging, and which did not. They also described elements of their embodied identities that supported feelings of belonging, such as personality traits and demographic markers. Authors coded based on the four elements of belonging as defined by [1] – competencies from belonging, opportunities to belong, motivations to belong, and perceptions of belonging. Interview data from 70 undergraduate computing students suggest great variability in student perspectives of belonging, with individual characteristics, or traits of the individual, and contextual characteristics from the academic environment serving to sustain a sense of belonging. In addition, our dataset is from Hispanic Serving institutions and emerging Hispanic Serving Institutions and indicate characteristics of departments that support student opportunities and competencies that promote belonging.

Introduction

While the term “belonging” has a colloquial meaning – to fit in, to be part of a community, to be accepted by others – its use in the engineering education literature has lacked theoretical specificity. As the meaning of belonging has been vague, its referent has been ill-defined in research. In other words, studies of belonging may lack clarity regarding to what or to whom people belong.

In this study, we employ the integrative belonging framework developed by Allen et al. [1] to understand how undergraduate computer science students consider their “fit” within their computer science academic departments. The integrative framework emphasizes four constructs in considering belonging: competencies for belonging, perceptions of belonging, opportunities for belonging, and motivations to belong. With these concepts as initial codes, we applied the theory to interview excerpts of 70 undergraduate students at eight Hispanic Serving Institutions (HSIs) and emerging HSIs spanning three regions of the United States.

The concept of belonging has been ubiquitous in discipline-based educational research over the past decade. For example, a search for the term “belonging” on the IEEE Explore database produced 25,710 hits in January 2024. Studies of belonging in engineering and computer science have shown that the individuals who are minoritized in some way in their fields report lower senses of belonging than those who are well-represented in their fields, which are white and

Asian men in many Western contexts [2]. Stout, Tamer and Wright found that among first-generation computer science students, those with strong GPAs had a greater sense of belonging than their peers [3]. In fact, computer science students' sense of belonging rated lower than participants in other science majors [4]. Stereotypes regarding who is well-suited for computer science influence a sense of belonging as well [5]. Norouzi et al. [6] applied a multivariate statistical model to understand belonging across multiple categories of difference (gender, background experience, perceptions of different demographic groups in the field of computing) and over time (at the beginning and end of a semester-long course). Their results indicate a similar pattern, which is that those who are underrepresented in the field generally have a lower sense of belonging. A study of admissions policies indicates that students who attend institutions with competitive department-level admissions have a lower sense of belonging, self-efficacy, and sense of the department as welcoming than those with more open admissions [7].

Some research on belonging in the computer science space indicates specific methods that support student sense of belonging and takes an active approach towards enhancing students' sense of community. For example, Geller [8] described the inclusion of a badge for a "women in computing" group that supported women in an undergraduate program. Reckniger et al. [9] employed a storytelling intervention for upper-level students to support perseverance in the major. They found those who watched storytelling videos of students struggling then viewed belonging more expansively than those who did not. Students' feeling of support from peers and their department correlated with a sense of belonging in a wide-scale study of women at research universities [1] indicating that peers, faculty, and staff have a role in creating sense of belonging for students in computer science.

Conceptual Framework

Allen et al. [1] have offered an integrative framework for belonging, which names four components. The framework was designed for "understanding, assessing, and cultivating belonging" [1, p. 87], thus it is intended to be used to recognize, discuss, and actively develop knowledge about belonging. This framework is useful to us in this work because it helps us to identify aspects of belonging that students describe when responding to an interview question about how they fit in their computer science departments. It illuminates what students view as important when they describe their sense of belonging in that we can see what they choose to tell about and what they view as important aspects of their departmental fit.

The first component named in Allen et al.'s [1] framework is competencies. These are social, emotional, and cultural competencies, which help a person relate to others in the target community (in the case of our study, the computer science department). Essentially, competencies are skills and abilities that enable relating and connecting. They are what allow relationships to form and people to interact. Without competencies, one would miss social cues or not connect with others. Competencies aid interactions in that an individual can use their skills to choose whether and how to align their behavior with social or group norms and expectations.

The second component is opportunities. Opportunities refers to possibilities for interacting and connecting. This includes events, people, spaces being available to facilitate the development of belonging [1]. Even when someone has the ability to belong (i.e., the competencies component),

opportunities must exist to enable belonging. That is, without opportunities, belonging cannot occur. If, for example, an individual is presented with a time, place, and group of people, then that individual has the opportunity to develop belonging. That type of situation is an opening that has the possibility of creating or enhancing a sense of belonging. In some cases, recognizing opportunities and taking up the opportunities involves student agency, and in other cases, when opportunities are part of the formal workings of the department, these opportunities relate to the norms of the community and are part of typical practice.

Next is the motivations component. This means the “need or desire to connect with others” [1, pp. 93-94]. Even when people have competencies and opportunities, they must also have motivations to drive them toward belonging. This is the component that encourages a person to pursue the interactions that can form or grow their connections with others. People vary in the degree to which they desire belonging, and their motivations are influenced by a variety of factors.

Finally, perceptions is the fourth aspect of belonging identified by Allen et al. [1]. Perceptions here refers to the way people feel and think about their belonging. It is necessarily subjective because it is one’s perspective on their own belonging, as assessed by each person individually. All of the other components inform the perceptions aspect of the framework; the ability to belong, having prospects for belonging, plus wanting to belong all affect how one perceives their belonging. This viewpoint is unique to the individual because it is about their own experiences.

These four aspects of belonging are said to “dynamically interact” [1, p. 92], influencing each other and also being influenced by context, time, and experiences. All of the components interact with each other, as a whole layered on top of each other and also interacting one factor with another at times. It may be simple to distinguish between the components in some cases, and they may be so intermixed that differentiating could be difficult in other cases.

Methods

The authors contend that qualitative methods are valuable in understanding complexities in learning processes, including the dynamic identity construction that plays out through engaging with the world [11]. We applied thematic coding based on the integrative belonging framework to 70 interview transcripts of computer science students in this qualitative interview study. We framed this exploratory qualitative study with two research questions. How do computer science students perceive the extent to which they belong in their computer science department? What aspects of their learning environment and aspects of their identities are salient in their assessments of their belonging?

Departmental Contexts

Interview participants came from eight departments that were engaged in a network of Hispanic Serving Institutions engaging in Broadening Participation in Computing activities, called the Computing Alliance for Hispanic-Serving Institutions (CAHSI). All participants were part of a National Science Foundation scholarship program that supported Pell-grant eligible students, many of whom were from demographic groups underrepresented in STEM. The university

departments were located in a western state, the Southwestern United States, and the MidAtlantic United States. The institutions varied in the extent that they enrolled Hispanic/LatinX students (institutions ranged from 20 to 85 percent Hispanic enrollment in the most recent U.S. IPEDS database) and the extent to which they enrolled African American/Black students (2 to 20 percent, with regional differences apparent in proportions of African American/Black students). Department sizes differed across institutions; annual degree production in computing ranged from 29 to 530 degrees in computing. In addition, the institutions overall served students with financial need to a greater degree than the average institution; Pell grant eligibility ranged from 32 to 58 percent of the student body, while in elite colleges, the average Pell eligible enrollees has dropped to 21% in recent years [12].

Data Collection Process

All interview participants were part of a scholarship program at their prospective computer science departments at the time of the interview. The interviews took place virtually or by telephone, at a day and time chosen by the participant. All interviews were transcribed and coded as part of a larger study of computer science identity and program engagement. For this paper, the coding focused on one portion of the transcript, which was the response to the item, “Do you “fit in” within your computer science department? In what ways?” The focus for this study was on this item because it allowed students to describe their perception of fit specific to the computer science department (rather than the field more generally) and provided an opportunity for participants to explain those perceptions as they related to the department.

Data Analysis Process

With the goal of applying Allen’s integrative framework, we began with the four parent codes of competencies, perceptions, motivations, and opportunities to belong. We realized that holistic coding of the response was needed to understand whether participants described themselves as “belonging” or “not belonging” to the department, and while no participants indicated they did NOT belong, a large portion of students were ambiguous in their response of belonging, indicating elements of themselves and of the computing department that conveyed belonging and others that did not. After coding each response using overlap thematic coding processes (i.e., passages could have more than one code), each passage was coded in a second round with child codes under three of the four categories. The first author completed the first round of coding, the second author reviewed the coding, and both authors met to come to agreement. Then, the second layer of codes was developed jointly in discussion. The first author recoded the passages, and making use of the child codes was the final coding step.

Results

Competencies for Belonging

In their interviews, students described their sense of belonging by telling of their competencies. As described by [1], competencies are the skills and abilities to connect. When students talked of groups of friends or individual relationships, we considered that evidence of competencies

because being able to develop and maintain relationships means having the social skills (i.e., competencies) to create belonging.

We found a good deal of evidence that students described belonging competencies, such as being with peers and navigating social relationships. Some students described themselves as “introverted”, and some additionally noted that many of their peers also have that tendency. One said it was “like most computer scientists are stereotyped to be”. Despite identifying themselves as introverted, however, they also talked about having made connections with others in their department. One student took this path in their interview, first mentioning that they are generally introverted, which seemed to mean they are not particularly gregarious and outgoing. Then, the student said, “I do have my own little clique, or crew, and those are all the people that I have study groups with.” The student also said that they “talk to a lot of research professors to see what they're doing” to find out whether they themselves are “interested in it too”. Thus, despite self-identifying as not particularly sociable, many students told of connections they had made with peers and professors.

While some students felt that they and their peers were more reserved, others described their peers as “friendly” and “outgoing”. One who said they felt like they fit well in the welcoming environment of their computer science department said, “I don't think I walked in, in the first few days or weeks of school, and felt like I was in a different crowd.” Not only did they find the atmosphere open and friendly, they immediately felt as if it were a good fit for them. They additionally said about the field more generally that they “don't think the computer science field is really too scary to come up against.” For this student, and for other interviewees, computer science generally is like their computer science department: open and sociable. Another student who shared similar ideas said, “Most people are usually friendly, so it's not hard to incorporate yourself. Most of them are nerds like me, and we usually get along and understand our references.” This student's comment about understanding each other's references seems to refer to cultural references relevant to their field and interests. This demonstrates competencies that are part of belonging in that the interviewee and their peers have a shared understanding and can make allusions to cultural touchstones or mention common hobbies, and most will recognize or appreciate those references.

In addition to finding competencies as described by the framework of Allen et al. [1], we also found that students explained their belonging by referring to other types of competencies. The framework focuses on competencies as social skills and abilities, and we extended the framework for our context to include academic and technical aspects of competencies as part of students' sense of belonging. We did this because so many students brought up these other aspects when explaining their fit within their department.

One additional area of competency that we identified in students' discussions of their departmental belonging was academic fit. One student confidently reported that that they fit “pretty well” and then went on to explain that they have the “same qualities as them” and are even a “step forward” because of their academic prowess. This interviewee told of “developing [their] own skills” during their “free time” so that they know more than their classmates on several computing topics. Another student referred to their academic competency when talking about belonging, saying that they had competed for a scholarship and had earned it because of

their academics. They said, “I know that I belong because I competed for this [scholarship] just like everybody else.” It was their academic proficiency that enabled them to earn the scholarship and become a computer science student, so they felt this was reason enough to justify/explain their belonging. Confidence in their academic skills was the main justification that many students gave for feeling that they fit in their department.

Another area of competency that some students cited when talking about belonging was technical competency. For example, they would name a particular area and relay that they were at the same level as their peers. One student talked about learning more about coding in C++, saying, “We all have an issue when it comes to coding, it's the same issue. It's not like it's something different.” This interviewee said they fit in well and then described being on par with peers in their coding work. Another student said they fit in their department and then went on to explain their work with Cozmo, a small robot. This student said they were programming the robot to “do certain tasks” and that working on this project, as part of a professor’s research work, was what made them feel that they belonged.

Perceptions of Belonging

Forty-two responses were coded in the affirmative, with the “Yes, I belong” code. These respondents did not appear to question their fit within their computer science department. Twenty-eight responses were coded as an ambiguous response to the item, with all of these providing some affirmative aspects, but with an incomplete sense of belonging or fit. The coding of these responses as affirmative and ambiguously affirmative were holistic, and were based on the complete response, which varied from one sentence to a full page of transcript text. Some examples appear below that were coded as described in the table.

Table 1.
Belonging Categories

Affirmative (i.e., unequivocal assessment of belonging) (n=42) Sample responses	Ambiguous affirmative (i.e., equivocal assessment of belonging) (n=28) Sample responses
“I would say I fit in well.”	“I feel like I fit okay.”
“Yeah, I think I fit in.”	“I think I feel good about the CS department. Sometimes, I feel like I don't fit.”
“Well, I feel like I am a pretty big part of it for sure.”	“Just pretty much. I'd say that it's just a weird fit.”
“Yeah, actually our community is pretty cool between us.”	“Yeah. I feel like in the sense of people wise, there's a lot of people I get along with. But I feel like if you ask anybody, if I'm walking down the street and they're like, guess my major, nobody ever guesses CS.”

“I would say pretty well.”	“It's never been a problem, but I feel like I don't blend in necessarily.”
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Quantification of fit

In the interview, the item we address in this study related to departmental fit, with no sense of quantification in the wording of the item. In some cases, however, students described their sense of fit as if on a scale. We documented this spontaneous occurrence in this paper as a part of perception, as it relates to the complexity of the notion of fit and may influence our future work on this topic. One participant described perceiving a lack of fit based on comments from peers and from faculty, though some supportive faculty encourage the student to ignore discouraging remarks.

"On a scale of one to ten, I feel a five. So, it's like 50/50.... So, like I said, if you don't know a lot of coding or if you don't grasp the concepts right away, the professors make you feel... And some students make you feel like you don't belong there, like you're not supposed to be there. You don't fit in. But then the other half is, 'Well, I'm doing fine for what I know.' And other faculty members say, 'Don't listen to the professors who tell you that.' You know what I mean? They give you a boost of confidence in a way."

Another student quantified belonging near the top of the scale based on a perception of understanding content: *"Like an eight, nine out of 10? Definitely. I, so I think I understand what's going on and I don't have a problem with understanding things. I dunno how else to say it."*

Characteristics of peers in the department lead to feeling of belonging

For some participants, the characteristics of their peers brought on a feeling of fit, or for others, a feeling of lack of belonging, based on their perceptions of those characteristics. For example, one student described how an initial feeling of being different than peers led to a more nuanced understanding of those in the major:

*"And I don't do the same things as other computer science people, but as I've been in computer science... At first, I thought I didn't belong even though I wanted to do it, but I've met more and more people who don't belong and then **I've realized there's not kind of one kind of person in computer science.** Yeah, you could kind of base it down to a stereotype, but everyone's so different."*

A student, who was older than their peers, described a complex feeling of being both an insider and an outsider, based on their stage of life:

*"Then the computer science, the other students, even though I'm older, **I think I fit in pretty good with them and I've made some friends, and it is a little weird still because I am older.** It's like, they're all talking about going out and partying, enjoying frats and stuff like that. I'm like, "Yeah, I'm just working on the weekend and hanging out with my dogs." Other than that, it's been pretty good."*

Demographic Markers of Peers in the Department

Some participants mentioned the ways in which their demographic markers did not match those of their peers. For this study, the demographic markers of gender were most pronounced. Two women described the complexities of belonging in their department as women in computer science learning communities. We note that demographic markers of race and ethnicity were not discussed, though over half of the students interviewed were part of racial and ethnic demographics that are underrepresented in computing. We hypothesize that race and ethnicity were less salient because students attended Hispanic Serving Institutions.

"I feel like I fit okay. I have my friend group, and we're all kind of on a similar page, and we work well together and stuff. But it's definitely at least obvious and noticeable that I am one of three girls in my classes."

"I feel like I fit into my department because I don't know if it's just... I'm not sure it just... It feels welcoming. I've never had an issue that felt like it was targeting me, but I don't want it to be overlooked at that there still aren't a lot of females. So mostly, no. Like, in one of my classes it's six women and 30 guys. And that's not the department's issue or anything. That's an observation that you can see."

Opportunities To Belong

In interviews with students, participants described opportunities they had for developing their sense of belonging within their computer science department. These opportunities varied from interviewer to interviewee. Some were formalized opportunities, (e.g., existing clubs and course meetings) and services (e.g., Teaching Assistant-led activities, Professor office hours), or scholarship programming (e.g., scholar meetings and related research activities). Formalized opportunities were taken up by nearly all research participants in multiple ways, yet we coded data based on whether they described these formal opportunities as they responded to a question about “fit” in their department. In this way, we interpreted these formal opportunities as salient to the respondents’ views of belonging.

For example, one participant described an experience attending a conference with departmental peers as beneficial for feeling a sense of belonging within the department: *“Now that I went to [technical conference] and experienced all of that, I feel like it's something we could all relate on, most of the people that went with me just on the trip. It's cool.”*

Another participant described the opportunity to participate as a peer leader as influential to their feeling part of the departmental community. Connecting her abilities for problem solving to being able share them with her peers improves her skills and also connects her to multiple students.

Informal Opportunities to Belong

Participants in our investigation were utilizing and/or creating informal opportunities to deepen a sense of belonging within their academic major departments in a variety of ways. In some cases,

participants described social patterns they were developing with their peers, and they indicated that these social patterns supported their feelings of belonging to their department and to their peer group. One student described how course attendance created an opportunity for socialization with peers, and they described the campus spaces that supported this socialization:

*“Well, usually it's every Wednesday, because we have computer programming Wednesday afternoon. During that time, we'll meet up, even if we go out to eat, we'll get the food and eat, and work or study together. But sometimes we'll study computer science, or sometimes we'll study on our own **but we'll always be together**. We always go to the CS lab to study, do our work there.”*

Another participant described her feeling of belonging in computer science as a comparison with the education department. The opportunities she has for informal conversation relates to her feelings of belonging in one department more than the other, and she compared the informal dialog she has with staff and faculty in one department versus the other:

*“The assistant of the math and computer science department, I love her. She's so nice. And she was like, “Why don't you ever go to the education department?” And I was like, “I don't feel like I fit in well.” I was like, “They're not diverse.” They are not as diverse as the computer and science and math people are. **And everyone to you is so friendly**. All my peers, people that I'm friends with are from the math and computer science department. But in math and computer science, I will see any one of them, and I will talk to them, and we will chat. And it's like, I wish I had this with my education department. But it's good that I have it in the math and computer science.”*

Limits to Taking Up Opportunities to Belong

Fitting in among departmental stakeholders was, in some cases, viewed as building social relationships through informal time together. We acknowledge that some participants in our study did not view their experience as one in which they could take up opportunities to improve their sense of belonging. Often this related to commuting to campus and to work schedules that the students managed on and off campus. Two responses appear below to illustrate this idea of lack of belonging opportunity.

“I don't really get involved socially that much just because I commute, so it's really kind of hard to maintain any kind of relationships.”

“I kind of don't [belong]. Because the computer science club, they meet on times where I can't meet, so I guess the only thing is attending ... I think there's a science fair today, and I'm not able to attend that or to just go and support my peers. But I feel like I don't really do anything with the school. I would like to, but I just feel like, again, I don't really have time since I'm working. And I do work the weekends, and that's mostly when the hackathons are.”

Motivations to Belong

In the analysis of interviews, motivations was the component of the Allen et al. [1] framework that was the least common. Some students did indicate their motivations to belong, though,

relaying a sense of their desire to connect with others. For some, their motivation stemmed from their interest in the computing field more generally, and for others it was about the individuals they noticed in their department.

Two interviewees positioned their motivations to belong to their computer science departments as being related to their belonging to computer science as a field [13]. These students were hesitant to declare that they belong in their departments and made qualified statements like, “I haven't really made too many friends in the CS department. I would say I do feel like an outsider,” but then saying a few sentences later said, “I think I do belong in CS. I think I never really stopped caring for it.” This student said the field of computer science is “so much bigger than the people that you meet in college, even though it would be nice to have my peers as friends and make memories that way.” They indicated that they are motivated to belong and do feel that they belong within the broader field of computer science, but they do not feel strongly like they belong (i.e., they are an “outsider”) within their department. They demonstrated a strong desire to connect with peers at their university by saying that they have made other connections there: “I do have friends in college, so it's just they are in different fields.” They explained their lack of connection to peers by pointing to personality differences such as when they said, “I have an outgoing personality, and a lot of the CS students don't.” In addition, they said their departmental peers were lacking motivations to belong in their statement that “there's not really a want to try and be social [on the part of my peers], so there's just kind of a weird kind of fit.” Another student who talked about their strong connection to the field but not a strong tie to their department noted, “I like the broadness that computer science can be viewed, so it's not like I'm learning something specific. I'm learning a lot of things.” They went on to say that they still enjoy their field and are not considering leaving it, but they have “kind of a mixed feeling” about whether they belong in their department. These students seem to be expressing the idea that they belong within the field of computer science, so therefore they must at least somewhat belong in their department.

Another student whose interview excerpts revealed the idea of motivations described how they came to see themselves as fitting in their department. This interviewee had entered the computer science department with ideas about how similar the students would be to each other, saying, “At first, I thought I didn't belong, even though I wanted to do it.” This student said they were not the person who was “gaming all the time”, they do not know “all the parts of how to build a PC”, and they also do not do “super big projects and just has done [them] since I was young”. Over time, they said that they “met more and more people who don't belong. And then I've realized there's not kind of one kind of person in computer science.” They gave the example that they have a “friend who's in computer science, and he's in tap dancing as well.” They came to see that “there's just so many different kinds of people, and that's why I feel like I fit in – because computer science needs all those kinds of different minds and creativities.” This student wanted to fit and modified their ideas of what it meant to belong after seeing and meeting many different people in their computer science department. The interviewee decided that because they did not really see many others who fit their expectations, they must all fit.

We could assume that interviewees who spoke of having social connections with peers, especially those who sought out or took up informal opportunities for belonging, as implicitly relaying information about their motivations for belonging. That seems like a fair assumption to

make, however, this analysis was aimed at identifying more explicit references to the components of belonging. In taking this approach, our analysis identified very few instances of motivations in the interview excerpts.

We hypothesize that the focus of the interview excerpts on the question of departmental belonging excluded talk of motivations because the question asked whether a student belonged, and most students then explained why they felt that they belonged. The interview did not include any follow-up questions about why a student had chosen to seek belonging or how much they had sought out opportunities to belong, which are questions that would likely elicit more motivations-oriented responses. Nor were questions focused on students' paths into computer science or their potential future careers in computer science, both of which could also draw out talk of motivations.

Discussion

We note how our diverse sample of students from HSIs of varying types influenced the findings related to belonging. Students who were from ethnic/racial groups underrepresented in computing fields did not note these elements of their identity as salient to feeling othered in the department. Women did, however, describe their gender as an element of their identity that made them unlike their peers. Participants perceived the characteristics of peer groups in different ways (e.g., friendly, supportive, introverted, nerdy). In some cases, participants viewed their peers in the same department differently, which could relate to cohort differences, differences in subgroups of peers, or individuals' perceptions of themselves as computer scientists.

Departmental culture may also play a role in students' perceptions of fit. Opportunities for belonging codes in the belonging interview item showed that departmental climate, formal and informal norms of interaction with peers and with faculty, and specific activities and support mechanisms for promoting retention in the major (e.g., student clubs, peer tutoring) were perceived as creating a sense of belonging by students in this interview study. An implication of this study is that the computing department has a role in creating opportunities for student belonging through formal, explicit mechanisms and through the development of norms that allow for students to see themselves in the computing major.

This model seemed comprehensive in covering the ways in which students talked about their fit within the computer science department. That is, all themes were addressed by the four categories in [1]. In coding the transcript excerpts, we did not identify any aspects of belonging that were not covered by the components of the framework. All concepts discussed by students fit into at least one, and often two to three, of the four parts of the framework.

We found that belonging as a binary is too simplistic; we found perceptions of belonging were complex and changed over time. Students drew on differing elements of their departmental experience to make claims about belonging (or not). The extent to which they acted like (i.e., characteristics) or looked like (i.e., demographic markers) their peers were leveraged to answer the interview question about belonging.

In extending the belonging framework to computer science, we addressed new types of competencies to explain students' fit within their departments, including academic and, to some extent, technical competencies. This expands the framework and may support the development of its use in more academic spaces. Our contribution also involves delineating examples within each of the four categories and investigating how these concepts play out in student talk. We find value in student interpretation of belonging on their own terms and in the complexity of their own experiences.

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References

- [1] K. A. Allen, M. L. Kern, C. S. Rozek, D. M. McInerney, and G. M. Slavich, "Belonging: A review of conceptual issues, an integrative framework, and directions for future research," *Australian Journal of Psychology*, vol. 73, no. 1, pp. 87-102, March 2021, doi: 10.1080/00049530.2021.1883409.
- [2] Catherine Mooney and Brett A. Becker. 2020. Sense of Belonging: The Intersectionality of Self-Identified Minority Status and Gender in Undergraduate Computer Science Students. In United Kingdom & Ireland Computing Education Research conference. (UKICER '20). Association for Computing Machinery, New York, NY, USA, 24–30. <https://doi.org/10.1145/3416465.3416476>
- [3] Stout, Jane G., Burçin Tamer, and Heather M. Wright. "Toward a Deeper Understanding of First Generation Students' Success in Computing." (2016).
- [4] Shamima Nasrin Runa, Anna Markella Antoniadi, Brett A. Becker, and Catherine Mooney. 2023. Student Sense of Belonging: The Role of Gender Identity and Minoritisation in Computing and Other Sciences. In Proceedings of the 25th Australasian Computing Education Conference (ACE '23). Association for Computing Machinery, New York, NY, USA, 87–96. <https://doi.org/10.1145/3576123.3576133>
- [5] Cheryan, Sapna, Victoria C. Plaut, Paul G. Davies, and Claude M. Steele. "Ambient belonging: how stereotypical cues impact gender participation in computer science." *Journal of personality and social psychology* 97, no. 6 (2009): 1045.
- [6] Norouzi, Narges, Hamidreza Habibi, Carmen Robinson, and Anna Sher. "An Equity-minded Multi-dimensional Framework for Exploring the Dynamics of Sense of Belonging in an Introductory CS Course." In Proceedings of the 2023 Conference on Innovation and Technology in Computer Science Education V. 1, pp. 131-137. 2023.
- [7] An Nguyen and Colleen M. Lewis. 2020. Competitive Enrollment Policies in Computing Departments Negatively Predict First-Year Students' Sense of Belonging, Self-Efficacy, and Perception of Department. In Proceedings of the 51st ACM Technical Symposium on Computer Science Education (SIGCSE '20). Association for Computing Machinery, New York, NY, USA, 685–691. <https://doi.org/10.1145/3328778.3366805>
- [8] Geller, James. "Fostering a sense of belonging in female computer science students." *Journal of computing sciences in colleges* 37, no. 3 (2021).

- [9] Reckinger, Shanon Marie, Chris Gregg, and Bryce E. Hughes. "Social-belonging intervention in a computer science systems course." 2021 ASEE Virtual Annual Conference Content Access. 2021.
- [10] Adler, P. A., Adler, P., & Fontana, A. (1987). Everyday life sociology. *Annual Review of Sociology*, 13(1), 217-235.
- [11] Sax, Linda J.; Blaney, Jennifer M.; Lehman, Kathleen J.; Rodriguez, Sarah L.; George, Kari L.; and Zavala, Christina, "Sense of Belonging in Computing: The Role of Introductory Courses for Women and Underrepresented Minority Students" (2018). Education Publications. 106.
https://lib.dr.iastate.edu/edu_pubs/106
- [12] <https://universitybusiness.com/your-student-body-has-fewer-pell-grant-students-than-10-years-ago/#:~:text=A%20new%20report%20from%20The,cohorts%20comprise%20Pell%20Deligible%20students>
- [13] LaPointe, Kirsi. "Narrating career, positioning identity: Career identity as a narrative practice." *Journal of vocational behavior* 77.1 (2010): 1-9.