Ethiopian Women Students' Recommendations for Enhancing Their Sense of Belonging in Engineering Education

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Abstract

It is well understood across diverse cultures and disciplines that a well-developed sense of belonging among students is vital to their academic success, persistence, and satisfaction in their major and learning environments. Ethiopia's Ministry of Education (MOE) has developed initiatives to educate the next generation of engineers, however, these initiatives can sometimes neglect the facilitation of inclusive environments in engineering. This qualitative study utilizes interviews with four Ethiopian women who were studying engineering in Ethiopian universities to explore how they felt their institutions could support them in developing and improving their sense of belonging in engineering. Our research question guiding this study is the following: How, according to Ethiopian women engineering students, could their sense of belonging be enhanced? What could the engineering school and university do to improve these women students' sense of belonging, according to the students? We collected data using narrative interviews, analyzed data using a thematic approach, and used a sense of belonging lens to guide the overall study. The findings center Ethiopian women students' advice and recommendations to their colleges and universities for improving women's sense of belonging in engineering education, which includes providing additional academic support for women, covering practical aspects of the engineering curricula (not just theories), creating a safe learning environment (e.g., practicing "strict" sexual harassment policy, ensuring reliable campus safety and security,

building separate libraries for women), providing a well-equipped learning environment (equipping labs with resources), monitoring the teaching-learning process, creating opportunities for women (e.g., jobs, scholarships), and hiring more women faculty who could inspire and serve as role-models for women students. This study suggests that it takes diverse and multi-faceted measures to enhance women engineering students' sense of belonging. This study also provides recommendations for the Ethiopian government, which may help make engineering a safer and more inclusive space where students of all genders feel they belong.

Keywords: Sense of belonging, gender, engineering student, Ethiopia, qualitative research

Introduction & Background

A sense of belonging is defined as being accepted, valued, included, and encouraged by the learning communities, for instance, teachers and peers [1]. In engineering learning contexts, a sense of belonging is a feeling of inclusion and willingness to engage with one's students, teachers, and learning materials in academic settings [2]. Further, a sense of belonging impacts the connection between students and their professors, which is a critical value for student success. Students' sense of belonging is important and helps them to think, feel and act as if they belong to their academic unit. For instance, a student who thinks and feels that they belong in the classroom is more likely to show up to class than a student who does not think and feel that they belong. Students' sense of belonging is a potential facet to enhance students' feelings towards their classroom environments, engagement in teaching and learning activities, and well-being in schools and universities [3]. Rainey and colleagues' [4] findings showed that classroom practices and faculty efforts in the learning environment support minoritized engineering students' sense of belonging. Further, a sense of belonging is important for historically marginalized students to

impact their psychological and academic experiences growth [5], [6]. One such student group in Ethiopia is women students majoring in engineering.

In Ethiopia, society has lower expectations for women, especially in engineering, a discipline stereotypically coded as a masculine profession [7], [8], [9], and women have historically had less access to higher education, particularly in engineering [7], [10]. According to Kassie [11] "females' underrepresentation was worse in science and engineering fields" (p. 1). However, recently the Ethiopian government has increased women's access to higher education and the engineering discipline [11]. Although access is an important step, it alone doesn't guarantee better participation, performance, persistence, and experience.

Based on available seats and the acceptance capacity of each higher education institution, Ethiopia has a centralized admissions system in which all institutions set undergraduate admissions by the Ethiopian Ministry of Education (Trines, 2018). Yearly, undergraduate student admission systems, including engineering students, are assigned to their study majors and universities largely decide by quota with less consideration of students' interests based on Ethiopian Higher Education Entrance Examination results which means the twelve-grade university entrance examination results [12], [13]. This indicates a student's admission process is less likely to include their interest in students' assignments to institutions and less preference to study majors. That is, many students (of all genders), especially those who score less on university entrance exams, have limited or do not have the autonomy and agency to choose what to study (their majors) and/or where to study (their universities). Given the national interest of the country to produce as many engineers to help with the transformation of the country into a

middle-income country, the possibility of students assigned to STEM fields, especially in engineering, without their interest is very likely in Ethiopia [13]. Because of this admissions policy, we expect that women students' admissions experiences might be one factor that impacts students' motivation and ability to develop a sense of belonging to an assigned university and study majors.

Several factors might influence women students' academic participation and experience in engineering, including a sense of belonging to a major, school, and/or university. Exploring the sense of belonging of women Ethiopian students in engineering is particularly important due to: (1) the study setting: Ethiopia is a patriarchal society that historically discriminated against women [14], (2) the discipline: engineering is a stereotypically masculine coded profession [15], [16], [17], and (3) the admission systems: Ethiopian ministry of education practices a centralized admissions system to assign students to universities and study programs [12]. The main research question of this study is: how, according to women students, would women students' sense of belonging be improved? More specifically, what should the engineering college and university do to improve women students' sense of belonging?

Methodology

Research site and participants

This study was conducted at an engineering school at one of the mid-sized public universities in Ethiopia in 2021. Four interviews were conducted with four women students pursuing engineering in diverse majors (key demographics are summarized in Table 1). We used purposive sampling [18] to recruit study participants based on inclusion criteria such as age

(need to be 18 years or older), discipline (enrolled in undergraduate engineering), gender (need to identify as a woman), seniority (being a fifth-year student, or above), and willingness to participate in the study. In addition, we considered fifth-year students with the belief that they could provide richer and more detailed responses about their academic experience due to the longevity of their stay in the university [18]. The recruitment strategies included professional networks, campus postings (fliers), emails, and snowball sampling.

Table 1. Participants' demographics: women students in engineering (n=4*)

Participants (pseudonyms)	Major (discipline)
Biftu	Civil Engineering
Meto	Electrical and Computer Engineering
Rom	Civil Engineering
Lidia	Construction Technology and Management Engineering

* = Participants are fifth-year students — the normal time span for Ethiopian university students to reach seniority.

Design and data collection methods

This study is part of the larger study which explored: women students' sense of belonging to their engineering program, the college, and the university; factors hindering and facilitating their sense of belonging; how their sense of belonging impacts their academic participation and experiences; and how, according to women students, the college and the university can improve women students' sense of belonging. For this paper, we will focus on the following research question: how, according to women students, could Ethiopian women engineering students'

sense of belonging be improved? More specifically, what could the engineering college and university do to improve Ethiopian women engineering students' sense of belonging? We used an exploratory qualitative inquiry using a narrative design emphasizing subjective meaning-making [19, pp. 254–256], [20]. Specifically, we used narrative semi-structured interviews, with an interview protocol composed of ten questions, for instance including questions such as:

1. What should the engineering college and university do to improve women students' sense of belonging?
2. Do you feel you belong to the engineering college?

   (a) If so, can you tell me a time when you felt you belonged to engineering? Why did you feel you belonged to college? Could you give me examples of when you do not feel a sense of belonging to an engineering college?

   (b) If not, can you tell me a time when you didn't feel you belonged to engineering? Why didn't feel you belonged to college? Could you give me examples of when you do not have a sense of belonging to an engineering college?

Following the receipt of IRB, we conducted the interviews in English, but in cases of participants with low English fluency, we used *Afaan Oromoo*, one of the widely spoken languages in Ethiopia. The interviewer, who is the first author of this paper, provided participants with interview questions in advance and gave them a range of ideas about what is meant by a sense of belonging. The interviews ranged from 40 to 50 minutes and were conducted remotely via Zoom technology; the preferred data collection platform as the study was conducted during the Covid-19 pandemic and the researcher was in the US with the participants in Ethiopia. We obtained consent from participants and collected demographic information virtually over email.

Data Coding and Analytical Approach

All interviews were audio-recorded. Due to the usage of two languages, meaning-based translation and transcription were conducted manually by the first author of the paper who is fluent in both languages. This study is cross-cultural research, where we used two languages during data collection. Thus, we used meaning-based translation to reduce the possibility of losing the complexity and richness of meanings and potential misinterpretations that may occur in a word-for-word translation [20], [22].

We engaged in inductive–iterative, and ongoing reading and coding of emergent insights, and deductive coding– applying a researcher-developed codebook composed of 15 codes [23], [24]. The sample analytic data processes were indicated in Table 2. At this point, we read the transcript excerpts and inserted codes as shown in column two of Table 2. For example, some preliminary codes included *not being interested in engineering, being interested in health science majors, and dislike Engineering majors.* For more examples of preliminary codes (alongside excerpts from an interview transcript) refer to column two of Table 2. We used Dedoose to facilitate coding and thematic analysis [25]. Then, we combined conceptually similar codes to form themes [23], [26]. At this step, we used the consistency of code names with research questions across all interviews and organize codes of similar meaning into categories to form themes. For example, the three preliminary codes mentioned earlier in this paragraph were combined into a theme of a *sense of belonging to Engineering.* For more examples refer to column three in Table 2. To enhance the quality and trustworthiness of the study planning, data collection, analysis, interpretations, and reporting, we solicited feedback from the research team on all steps of the study. This included but was not limited to revising the interview protocol and

codebook, piloting interviews, and soliciting feedback from co-authors and other colleagues as coding and analysis progressed through the project [25].

Table 2. Example analytic process for data excerpts

Interview excerpts [1]	**Preliminary codes [2]**	**Themes [3]**
… [1] Engineering was not my choice. I do not like electrical and computer engineering. I wish not to identify with it. The reason is my interest was to major in health-related disciplines. [2] I used to like and study Health-related subjects like Biology. [3] I never thought of majoring in engineering. The root of engineering is Physics, and I did not like Physics, and due to that, I do not like engineering as well. … [4] The learning environment has to inspire women students. Further, it is clear that engineering is a difficult major. [4]Thus, the college should provide additional academic support for female students. … [5] Second, it should create a conducive opportunity to create a tutorial class for female students separately. Third, [6]engineering and technology colleges should create an opportunity for different training…. The university has to fulfill what students need, for instance, [7] establishing a separate library for women students. The university should also ensure campus safety/security and create a scholarship opportunity for students….[8] facility such as WIFI internet around the residence and [9] libraries at a close location to women's	[1] Not interested in Engineering [2] Interested in health science majors [3] Dislike Engineering majors [4] Conducive learning environments [7] Separate study room for women [10] Create a promising interaction environment with faculty [13] Implement a strict policy for sexual harassment [5] Tutorial classes for women [6] Training events for women [8] WIFI internet around the dormitory	Sense of belonging to Engineering (1, 2, 3) Creating a conducive environment (4, 7, 10, 13) Additional academic support for women (5, 6, 8, 9, 11,

residence…. [10] Creating a good environment that makes good interaction with male faculty, [11] financial supports for some poor women students. [12] Giving additional and supportive tutorials for women. [13]There should be strict laws and regulations…preventing sexual harassment for all university students and workers.	[9] WIFI internet around the library [11] Financial supports for women students [12] Supportive tutorials for women students	12)

Positionality statements

The four research team members comprise two Black, Ethiopian men and two White, American women. The first author who was the leader of this research project is a Black man who is also a senior doctoral student in Engineering Education. The third author is also a Black man, specializing in Civil Engineering, and is a faculty member and department head at one of the universities in Ethiopia, teaching diverse engineering courses. The second author is a senior doctoral student in Engineering Education and their research focuses on critical methodologies in engineering education. The fourth author is an engineering education professor and the advisor of the first and second authors. She is also a scholar, with some of her research agenda involving diversity, equity, and inclusion-driven academic research efforts.

All four research team members study and/or research in engineering education and share commitments to equity and justice in education. Each of the research team members also shares some identities with the study participants, which may generally enhance the understanding and interpretations of the experiences of the study participants [27]. Our shared personal identities with the participants and/or research topic provided a starting place for intuitive knowledge about our research topic that facilitates understanding the participants' experiences [27].

Accordingly, the two women co-authors share a gender identity with the study participants and may share associated women's experiences in higher education, although they have not experienced higher education in Ethiopia. The two Black men research team members share additional identities with the study participants, including nationality, ethnicity, being trilingual, and major—engineering discipline. They both studied engineering, taught engineering courses, and conducted some research at one of the public universities in Ethiopia. They also served as department heads, one at one of the public universities and the other at a private college in Ethiopia. In those capacities, and their experiences as instructors, researchers, and department heads, they had an opportunity to learn about some challenges women in Ethiopia face in universities, especially in engineering.

The two Black men research team members also have a sister who studied engineering (bachelor's degree) and is pursuing a master's degree in engineering. As siblings, who have close contact with their sister to support her in her academic pursuit, they learned some of the struggles women in Ethiopia might face in higher education, especially in engineering departments. Further, both men know they haven't experienced the many challenges women students go through in engineering in Ethiopia. While some of their identities advantaged them to relate to the participants during data collection and helped them during data analysis, they realized that they still have many blind spots in understanding women students' experiences. To bridge this gap, they elicited feedback from the research team on all steps of the study, including input on interview protocol and the codebook. While they acknowledge that it is impossible to eliminate all biases to address major ones, they engaged in multiple meetings to debrief their understandings of major themes, resolve misunderstandings, and agree on disparate concepts

grounded on researchers' perspective differences and/or subjective experiences. Additionally, they engaged in iterative and multiple rounds of data readings, coding, and analysis.

Findings and discussions

The women students were asked to provide some advice as to how the engineering school and the university could improve women students' sense of belonging. Specifically, we asked them what the engineering college and university should do to improve women students' sense of belonging. The students provided the following recommendations:

Finding 1. Additional academic support can enhance women students' learning experiences and sense of belonging

Most participants emphasized the need to provide additional academic support for women students by "giving additional and supportive tutorials for women" (Rom) because they think engineering is a difficult major and because some of the students did not choose engineering and did not have K-12 education that prepared them for engineering education [28]. "It is clear that engineering is a difficult major, thus, the college should provide additional academic support for female students" (Meto). This quote indicates that providing additional academic support and creating learning intervention opportunities for women students can help increase their participation, learning experiences, and mastery level of difficult majors' science knowledge and skills. Thus, improved learning experiences might enhance women students' sense of belonging. A similar study finding indicated by Hausmann [29] showed that schools and instructors develop instructional interventions to improve students' sense of belonging.

Given some women students in Ethiopia are forced into engineering by the government (as is the case with Rom and Meto), those who were forced into the major they did not choose are likely not to have a solid academic background in the subject. Engineering schools were also unprepared and not equipped with robust educational support programs (such as tutorial classes for academically struggling students). As a result, academically low-performing students, especially those without strong academic backgrounds in engineering would like additional academic support to improve their learning experiences. This implies that women students' learning experiences are impacted by external factors in learning environments. When a student chooses a major that connects to what the student likes to pursue, their engagement deepens as they are willing to spend time exploring their goals. Further, for women students to function optimally in their colleges and universities, the choice of the major must be based on their interests. For instance, personal interest in the major of study is very influential in students' major decisions [30] and could enhance students' sense of belonging [31], [32]. Furthermore, embedding peer mentors in academic experiences improves a sense of inclusion in the learning space which is directly related to students' sense of belonging [31].

Finding 2. The need to focus on practice (not just theories)

Because engineering requires practical aspects, the students want the college to cover practical aspects through labs. "Engineering education is an education of theory and practice; they should ensure that both theory and practice are covered side-by-side. We often cover just theories; we are missing a lot of practical aspects" (Biftu). Meto hoped to compensate for the practical aspects she missed at lower grades thus wanting the college to focus on labs. This implies that laboratory and hands-on learning experiences appear to aid in the development of women students' subject-content mastery. In addition, conducting practical, hands-on work along with theoretical

knowledge in classroom learning appears to play a crucial role in enhancing interest in what and how they learn, which will also likely improve their sense of belonging and learning experiences. Hofstein [33] conducted a study on the role of the laboratory in science teaching and learning and found that the use of experimentation and investigation can promote students' performance and achievement, motivation, and creativity in science learning. In addition, hands-on learning can provide a high sense of school belonging because it can increase students' attachment feelings to their schools and academic success [34], [35].

Finding 3. Creating a safe and accessible environment improve students' learning experiences

The students stressed that the college should create a favorable environment, which includes installing internet, showcasing ways to "inspire women students" (Meto), rewarding outstanding women, creating a sense of motivation and competition, creating a good environment that makes good interaction with male faculty, and providing financial support for some women students who are from a low socio-economic status.

The students did not suggest that the facilities for women on campus were less equipped than for men. However, due to the widespread sexual violence (e.g., sexual harassment) and hostility towards women, the students were unable to equitably access the available resources with men, especially using libraries, internet (Wi-Fi spots), and study spaces during the night. Sidelil and colleagues explain "Women's restricted and inequitable use of space on the campus is directly attributable to the pervasiveness of sexual harassment as a manifestation of hostile gender relations enabled by institutional culture" [36, p. 7]. Thus, exposing men and women students to the same resources and services does not always guarantee the same/fair use (access) in practice. Moreover, Meto suggests that "the college should also hire faculty not just based on their GPAs,

but also they should assess their teaching ability and experience, and they should monitor how they are teaching" (Meto).

Like their suggestion to the college, the students advised that the university creates a conducive learning environment that includes equipping laboratories, "establishing a separate library for women students, ensuring a campus safety" (Rom), and "providing psychological and motivational advice" (Biftu).

Finding 4. Sexual harassment prevention strict laws and practices

Sexual harassment of university women students is common in Ethiopia [36], [37], and Lidia recommends that "there should be strict laws and regulations…preventing several harassments for all university students and workers." Lidia's call for a firm harassment policy and its practical implementation (with no exception) stems from the inaction and toothless nature of such policies. Commonly, many universities in Ethiopia claim that they have a zero-tolerance policy for sexual harassment, but in practice do not implement a zero-tolerance policy due to "widespread denial, misrecognition and…institutional neglect and inaction" [36, p. 12]. This also indicates the presence and persistence of some forms of sexual harassment across cultures.

Finding 5. Creating opportunities for women students may have an impact on students' sense of belonging to their engineering college and institutions

The students recommend that the university creates opportunities for women that include job opportunities (Meto, Biftu), scholarships (Rom), and financial support for low-income women students (Biftu). "This is because many students stop following their goals due to a lack of

financial support. The university should search for such low-income students and support, and they will be motivated and may not drop out" (Biftu).

> The university should work to keep outstanding women students as the university faculty. This is helpful for other women students because they look up to them and get motivated while they attend their university education. Increasing the number of women faculty in the university because other women students get inspired, join engineering majors, and work hard to be great at their education. (Biftu).

Allen [35] conducted a study on the implication of school values, and Halkiyo [38] explore the different supports in the form of learning interventions such as scholarships and creating learning opportunities and found that the learning environments can positively support students' learning culture and increase student belonging [32].

Students also believe that if the university were to hire more women faculty their sense of belonging would be increased as women engineering faculty could serve as role models and inspire women students. Such attempts may improve women students' motivation to persist in the program. For instance, Bettingger and Long's [39] study findings suggest that female teachers have a positive role model effect on women and historically marginalized students in academic settings than males and can positively influence their course selection and major choice.

Conclusions and implications

The participants advised the engineering college and the university to provide additional support for women students. This support included academic support (e.g., tutorial classes), economic support (e.g., jobs, rewards, and/or scholarships for outstanding women students, and supporting low-income women), hands-on learning support (e.g., an equipped learning environment and

accessible learning tools including internet and equipped labs, a curriculum that focuses on hands-on learning and not only theories), personal-safety support for instance, ensuring reliable campus safety and security and the practicing a "strict" sexual harassment policy to combat sexual harassment which is common in Ethiopia [40], [41], and mentoring support (e.g., prioritizing hiring more women faculty who could inspire and be role-models for other women students). This advice and recommendations indicate that it takes diverse and multiple strategies and interventions to support and enhance women students' sense of belonging in engineering. Addressing one issue, for instance, hiring more women faculty, may not address the entire challenge: enhancing women students' sense of belonging in engineering. In addition to hiring more women faculty, Ethiopian universities may want to infuse professional development efforts that enhance ethics, professionalism, and democratic culture (especially for men students and men faculty), this implies creating a harassment-free culture. Thus, the engineering college, the university, and the government of Ethiopia may listen to the women students' advice and recommendations to improve women students' sense of belonging to make engineering a safer and more inclusive space for all students.

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