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Exploring how Ethiopian women students perceive a sense of belonging in engineering higher education

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In this study, we explored four undergraduate engineering women students' sense of belonging in their engineering major, engineering college, and university in Ethiopia. Specifically, we explored how engineering women students perceived their sense of belonging in the engineering programme and how the perceived sense of belonging impacted their academic participation and experience. We conducted an exploratory qualitative study through narrative interviews, thematic analysis, and a 'sense of belonging' lens to guide the study. Findings indicated that two participants who chose the engineering major themselves felt a sense of belonging in engineering, while one who was assigned to engineering by the government did not feel a sense of belonging in her major, and one experienced a partial sense of belonging. The students indicated that having the autonomy to choose majors of their interest affected them in many ways: their motivation, persistence, performance, experience, sense of belonging, and whether to stay in the profession after graduation or not. The Ethiopian government may need to prioritise making engineering a safer and more inclusive space where students of all genders feel they belong before forcing more women into the major. Furthermore, findings suggest the Ethiopian Ministry of Education might consider allowing the autonomy and agency of women students in choosing their major and/or university whereby they can make pragmatic decisions of what to study, where, and for what purpose.

Keywords: sense of belonging; women students; engineering; Ethiopia; qualitative research

Introduction

A sense of belonging is a fundamental human need for individuals to belong and be accepted, respected, and encouraged by a group or community of people (Goodenow, 1993; Marshall et al., 2012). The concept of sense of belonging has broader definitions in the literature but was

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introduced as a way of indicating ‘students’ integration within their academic unit ... and serves as a measure of the perceived degree of inclusion within that unit’ (Lee et al., 2019, p. 2). Some of the common aspects that sense of belonging covers includes school-based relationships, student-teacher relationships, experiences with peers, and students’ general feelings about the school (Lee et al., 2019; Strayhorn, 2019). In addition, a sense of belonging is related to self-perceptions of fit within a given context, including classroom environment, campus community, and affinity groups (Hagerty & Patusky, 1995; Smith et al., 2012).

In engineering learning contexts, a sense of belonging is a perception of acceptance, inclusion in learning environments, and willingness of diverse student groups to engage with peers, teachers, and learning materials in academic settings (Smith et al., 2012; Wilson et al., 2015). For example, Rainey and colleagues’ (2021) findings showed that classroom practices and faculty efforts could support minoritised engineering students’ sense of belonging in learning environments. Further, a sense of belonging is crucial for students who are minoritised in the institutions they attend and/or in the major they pursue due to gender, race, ethnicity, or sexual identity. For instance, a sense of belonging could be more important for Black students who attend predominantly white institutions (PWIs), international students attending US universities, and Black women students pursuing engineering fields (Johnson et al., 2007; Tate & Linn, 2005). One such student group in Ethiopia is women students majoring in engineering.

In Ethiopia, society has lower expectations of women, especially in engineering, a discipline stereotypically coded as a man’s profession (EqualEngineers, 2019; Tadesse, 2021; Yossi, 2017), and women have historically had less access to higher education, particularly in engineering (Asfaw, 2012). While under-representation is problematic in higher education in Ethiopia in general, it is worse in the science and engineering fields (Kassie, 2018). However, the Ethiopian government has recently increased women students’ access to higher education and engineering (Kassie, 2018). Although access is an important step, it does not alone guarantee better participation, performance, persistence, and experience. In Ethiopia, women students’ graduation rates, performance, and participation in university education are low, and their educational attainment, especially in science and engineering, is lower than that of men students (Kassie, 2018). Several factors affect women students’ academic participation and experience in engineering, and a sense of belonging might be one of them.

Exploring a sense of belonging of Ethiopian women students in engineering is particularly important for three reasons: (1) the study setting: Ethiopia is a patriarchal society that historically has discriminated against women (Jebessa et al., 2015); (2) the discipline: engineering is a stereotypically masculine-coded profession (Cheryan et al., 2020; Jagacinski, 1987); and (3) the admission system: the Ethiopian Ministry of Education (MOE) uses a centralised admission system to assign students to universities and study programmes. Through the following specific research questions, this study explored factors hindering and facilitating women students' sense of belonging in engineering and how the perceived sense of belonging impacted their academic participation and experiences. The study addresses these two questions: (1) How do women students studying engineering in Ethiopian universities perceive a sense of belonging in their major, engineering college, and university? and (2) How does women engineering students' perceived sense of belonging influence their academic participation and experiences?

Literature review

Globally, more women are enrolling in universities than men. In 2019, 54% of students awarded a degree were women (Zahidi, 2022). Despite this trend, gender disparities in tertiary education have been a topic of concern for many years (Saadat et al., 2022). Women face more discrimination regarding access to education (Hurtado, 2021; Zahidi, 2022). However, the gender gap in education has decreased significantly, especially in primary education (Hurtado, 2021). According to the Global Gender Gap Report (Zahidi, 2022), in 2020, 88% of females worldwide had primary education compared to 91% of males; the gender gap is most prevalent in STEM fields, with women being under-represented, and women's participation in health and welfare fields decreased while it increased in education. The distribution of learners by field in 2019 showed that tertiary education continued to be segregated by gender; for example, between 2013 and 2019, the gender gap in ICT and engineering and manufacturing remained mostly intact (Hurtado, 2021; Zahidi, 2022).

The Ethiopian context, however, is different. Women's access to higher education has improved, but their attrition has continued to be a challenge (Tamrat, 2022), resulting in the 'worse female under-representation in science and engineering fields' (Kassie, 2018, p. 1). In his study that assessed the student attrition rates in 15 Ethiopian public universities, Tamrat (2022) observed

an alarming rate of consistent loss of female students across all 15 universities. He identified that ‘more than half of female students enrolled in most universities do not progress to the final year’ (Tamrat, 2022, p. 7). He thus concluded that men’s graduation rates are higher than women’s graduation rates. In research conducted in 2018 at Addis Ababa University, the Ethiopian flagship university, Kassie (2018) identified that:

The gender gap in enrolments, graduates, and honors lists in the last five years remains wide in favor of males. Females’ under-representation was worse in science and engineering ... females’ educational attainment was lower as compared to males, and their attainment in science and engineering fields was lower than that in the social sciences (2018, p. 1).

The above quote demonstrates wide and apparent gender gaps in engineering (compared to social sciences), honours, and the persistence of the gender gaps over time.

According to Asfaw (2012), there are three significant factors hindering women in education and gender disparity in Ethiopia: ‘(1) the challenge of translating policies into practice, (2) gender factors outside of education, and (3) favoritism of boys’ (p. 2). Additionally, gender equity in education is affected by socio-psychological, academic guidance and counselling, and financial challenges (Tamrat, 2022).

Further, sexual violence is also one of the common challenges for women students in Ethiopian higher education institutions (Mamaru et al., 2015; Sidelil et al., 2022; Hassen & Mohammed 2021), and most do not share what happened to them. For instance, Hassen & Mohammed (2021) assessed the prevalence of sexual violence and associated factors among female students at Debre Berhan University—a public university in Ethiopia in 2016. In their findings, out of a total of 627 undergraduate female students selected via multistage sampling technique and surveyed, 51.8% experienced sexual violence, 12.8% experienced attempted rape, 9.8% experienced rape, and “more than half of the rape victims (35, 57.3%) did not share their experiences with anyone” (Hassen & Mohammed, 2021, p. 1). Sidelil et al. (2022) conducted a study with women students and found that sexual harassment such as staring, insults of a sexual nature, unwanted and persistent requests for dates and sexual relationships, and threatening students with grades to advance the sexual interests of the perpetrators ‘is rampant, normalised, and persistent within universities, especially in STEM institutions’ (p. 4). Consequently, the learning environment is

often hostile for women: ‘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’ (Sidelil et al., 2022, p. 7). Some universities have a zero-tolerance policy for sexual harassment (Bezabeh, 2016; Marsh et al., 2009). Unfortunately, they do not enforce this policy due to ‘absence of clear policy directions, widespread denial, misrecognition and inaction about this prevalence, which leads to institutional neglect and inaction’ (Sidelil et al., 2022, p. 12).

Based on available places and the acceptance capacity of each university, Ethiopia has a centralised admissions system in which all institutions are set undergraduate admissions by the Ethiopian MOE (Trines, 2018). In theory, prospective students indicate a prioritised/ordered list of majors they want to pursue and/or universities they wish to attend. Thus, in principle, while some students prioritise getting a major of choice (over the learning institutions), others prioritise attending the university of their preference (whatever the major is). A very few outstanding students are fortunate to major in the field of choice in their first-choice learning institutions. The majority, however, including engineering students, are assigned to their study majors and universities largely decided by quota, with little consideration of students’ interests, based on Ethiopian Higher Education entrance examination results (Halkiyio et al., 2023; Trines, 2018). This means, ‘students are admitted to the programme after scoring above a centrally determined admission cut-off point on a pre-college entrance exam’ (Gofere, 2022, p. 2). This indicates a student’s admission process is less likely to include their interest in their assignment to learning institutions and/or their study majors (Halkiyio et al., 2023). That is, many students of all genders, especially those who score less on university entrance exams, have limited autonomy and agency to choose what to study (their majors) and/or where to study (their universities) (Trines, 2018), hence the career they want to pursue after graduation. Thus, except for some outstanding students who may be assigned to the major of choice, the central admissions system plays an important part for most of the students in determining whether they do the courses they want, also hindering their sense of belonging in the major.

Given the national interest of the country to produce as many engineers as possible to help with the transformation of the country into a middle-income one, the likelihood of students assigned to STEM fields against their interest, especially in engineering, is very high in Ethiopia.

Because of this admissions policy, we expect that women students' admission experiences might be one factor that impacts their motivation and ability to develop a sense of belonging in an assigned university and major.

Globally, many countries are increasingly adopting centralized student admission systems (Kutscher et al., 2023). In centralized student admission systems, a single body oversees the admission process across multiple institutions. Proponents of these centralized admission systems claim that these processes make enrolment processes more transparent, efficient, and equitable (Elacqua, 2021; Kutscher et al., 2023). However, there is growing concern that these centralized admission systems might not make enrolment processes more equitable and could unintentionally lead to more segregation (e.g., they can lead to less socio-economic diversity in schools (Kutscher et al., 2023)). In decentralized student admission systems, student admission processes are overseen by an individual institution or program. Decentralized student admission systems can be a strength as the criteria for admission could be better aligned with the institution's values. A weakness of decentralized student admission systems is that it can be difficult for potential students to navigate many different admission systems.

In Ethiopia, there is a centralized student admission system, where the government selects the institution that a student will study within. Institutions place these selected students into academic units, but are required by the government to place 70% of students into science and engineering and 30% in social science, humanities, and education (Mekonnen et al., 2021). The administrators have no autonomy in decision-making over admissions and little autonomy over academic unit placement, and students have even less autonomy or agency in these decisions. Because students have little control over these placements in their institution or academic unit, they likely feel a loss of agency and feel disempowered, which would easily lead to a loss of sense of belonging. In a United Nations Research Institute for Social Development discussion paper (Kabeer, 1999), there is a discussion about the importance of empowering women through policy choices. These centralized student admission systems and requirements for placement of students in academic units may claim to encourage more gender equity, but because they strip the power of women in their countries even more by forcing them into specific universities and majors, may instead be reproducing gender inequality. Kabeer (1999) explains that 'one way of thinking about power is in terms of ability to make choices: to be disempowered, therefore, implies to be denied choice'

(1999, p. 8). In the case of these centralized student admission systems and restrictions on placement of students in academic units, governments are disempowering women, thus denying them their choice.

Theoretical framework

This study's theoretical framework is anchored in the concept of a sense of belonging, emphasizing the human need for both social and academic integration. Strayhorn (2019) posits that a sense of belonging is a core motivator, with social identities intersecting to influence college students' belonging. McLaren (2009) further defines a sense of belonging as "personal involvement and integration within a system or environment, wherein individuals feel they hold a unique role" (p.3). Building on Maslow's (1943) perspective of a sense of belonging as the need for interpersonal connections and acceptance, Strayhorn highlights how individuals seek relationships to fulfill this need. The conceptualization of a sense of belonging within educational settings encompasses perceptions of acceptance, membership, and sharing of lived experiences, thus fostering intentional connections and learning opportunities. Strayhorn (2019) underscores how belonging informs students' affiliation with disciplines, peers, and institutions, impacting their academic engagement and outcomes.

Previous research, exemplified by Xu and Lastrapes (2022), Abrica et al. (2022), and Cwik & Singh (2022), demonstrate the significance of a sense of belonging in various contexts, such as STEM career interest, community building, and academic performance. For instance, in studying the impact of a STEM-related sense of belonging on career interest, Xu and Lastrapes (2022) found that 'female students' STEM sense of belonging had an indirect impact on their career interest via its correlation with STEM attitudes' (p. 1). Abrica et al. (2022) also used a sense of belonging in study community building within a STEM intervention programme with a focus on Latinx male undergraduates' experiences. Similarly, in studying students' sense of belonging in introductory physics courses for bioscience majors, Cwik & Singh (2022) found that 'women had a lower sense of belonging and grade than men in the course and that the student's sense of belonging played a major role in predicting students' grade in the course' (p.1). Moreover, in studying how Latinx dual credit earners describe their sense of belonging in engineering programmes, Allen et al. (2018) concluded that while the interactions (with faculty, advisors, and peers) facilitated a strong sense

of belonging, ‘the size and rigor of classes, distance to campus, outside responsibilities, and feeling like an outsider’ hindered students’ sense of belonging at the institution (p. 1). These studies show the importance of understanding sense of belonging within different contexts.

This study positions a sense of belonging as a crucial lens for understanding and enhancing students’ experiences within academic environments. We conceptualise a sense of belonging in learning environments as students’ perceptions of acceptance, of being a member, and claiming lived experiences within academic settings, for instance, sharing personal differences with peers, classmates, or faculty. The above conceptual definition is adopted to understand and examine what helps students feel belonging within a university, or engineering discipline, to create intentional connections and learning experiences.

Methodology

Research context

This study was conducted in Ethiopia – a patriarchal society where men hold dominant positions in the economy, politics, leadership, socio-cultural domain, the university professoriate, and certain majors and professions, such as engineering (EqualEngineers, 2019; Tadesse, 2021; Yossi, 2017). Historically, women in Ethiopia have faced discrimination, with limited representation in influential social, cultural, and political roles. For example, there has been no woman prime minister or speaker in the parliament, and leadership roles in major religions have been exclusively held by men. Household headship has traditionally been assigned to husbands. Men have dominated tertiary education. University leadership roles (e.g., board directors, university presidents and vice presidents, college deans, school directors, and department heads) have always been dominated by men. Society has largely preferred daughters to marry at an early age, be ‘good/submissive’ wives, and have children rather than, for instance, pursue higher education and become professors, engineers, or scientists. Thus historically, fewer women students have been admitted to universities and non-STEM majors. Women students who do enrol face pervasive gender stereotypes, sexual harassment, and violence (Dea, 2016).

To address these disparities, the Ethiopian government introduced gender-related policies and laws aimed at promoting gender inclusivity across all aspects of life, including education, politics,

economy, and leadership. In the government's pursuit of becoming a middle-income country, Ethiopia implemented measures to increase the number of STEM graduates, intentionally including both men and women. While these gender policies are commendable on paper, critics argue that their implementation has been limited due to inadequate infrastructure and resources. It is worth noting, however, that recent efforts by Prime Minister Abiy Ahmed, who assumed office in 2018, have brought about significant changes. These include appointing the first woman president, head of the Supreme Court, and head of the Electoral Board, as well as increasing women's representation in parliament from under 5% to 38% (Bishu, 2022). The Ethiopian cabinet has also achieved gender parity, with women occupying from less than 9%, to '50 % of the government's top ministerial positions' (Belete et al., 2022, p. 72). Despite these circumstances, few women in Ethiopia pursue university studies, including engineering, and most still occupy largely marginalised positions in society.

Research site and participants

This study was conducted at an engineering college 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 (see key demographics summarised in Table 1). We used purposive sampling (Tongco, 2007) to recruit study participants based on inclusion criteria such as age (18 years or older), discipline (enrolled in undergraduate engineering), gender (identify as women), seniority (fifth year or above), and willingness to participate in the study. In addition, we considered fifth-year students in the belief that they could provide richer and more detailed responses about their academic experiences due to the longevity of their stay in the university (Tongco, 2007). The recruitment strategies include professional networks, campus postings, 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

We used an exploratory qualitative inquiry using a narrative design emphasising subjective meaning-making (Crotty, 1998). Specifically, we used narrative semi-structured interviews, with an interview protocol composed of ten questions (see appendix for the protocol). The interview protocol began with a question that elicited the respondents' narratives of how they became engineering students. The protocol also included questions about women students' sense of belonging within their engineering programme, the college, and the university, factors hindering and facilitating their sense of belonging, and how their sense of belonging impacted their academic participation and experiences. Some interview questions included:

- How would you describe your education journey?
- Was engineering your first choice?
 - If so, what made you decide to major in engineering?
 - If not, who assigned you and why?
- Do you feel you belong in engineering?
 - If so, why do you feel a sense of belonging in engineering? Could you give me an example of when you do feel a sense of belonging in engineering?
 - If not, why? Could you give me an example of when you do not feel a sense of belonging in engineering?
- What does your interaction look like with your peers and faculty, and how does their gender affect your interaction?

Following the receipt of Institutional Review Board (IRB) approval, we conducted the interviews in English. In cases of participants with low English fluency, we used Afaan Oromoo, one of the widely spoken languages in Ethiopia. The interviewer, the first author of this paper, provided participants with interview questions in advance and gave them a range of ideas about what a sense of belonging means. While we recognise that providing interview questions in advance could hinder data quality (in case the participants artificially prepared possible responses), such an approach benefited the study outcome. It significantly enhanced the efficiency of the data collection process when the interviewer and the participants experienced multiple interruptions due to the weak internet signal. That is, by having the interview questions in advance, participants

spent much of their time responding to the questions instead of struggling to hear and understand them. 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 interviewer (Jemal) was in the US with the participants in Ethiopia. We compensated the participants for their time and ideas. Two were compensated 23 USD each for participating in the interview, while the remaining two were compensated 35 USD each for participating in the interview and sending additional data through structured email because of fluctuating communication during interviews due to the poor network connection. Even though there was some risk of biasing participants, it was important to follow best practices around ethical compensation for research participants and to treat our participants fairly and avoid any possibility of taking advantage of them (Gelinis et al., 2018). The compensation was included in the IRB application at our institution and details of compensation were included in the consent form. Further, we obtained consent from participants and collected demographic information via 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 by Jemal, the first author, who is fluent in both languages. Another PhD holder who was not one of the co-authors checked the accuracy of the translations to help confirm the translations and reduce researcher bias. This independent researcher was Ethiopian-born, trilingual (fluent in the languages used in the study) and had expertise in qualitative inquiries and publications. In addition, this study was considered 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 (Birbili, 2000; Liamputtong, 2010).

Data coding and analysis were conducted in three steps. First, 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 (Creswell & Creswell, 2017). At this stage, we read the transcripts and inserted codes as shown in column three of Table 2. For example, some preliminary codes included *civil engineering as my first choice*, *MOE assigned to civil engineering*, and *study at the 5th choice university*. In the second step, we organised the codes by

checking the consistency of code names with the research questions across all interview transcripts. Third, we organised codes of similar meaning into categories to form themes (Creswell & Creswell, 2017). For example, the three preliminary codes mentioned earlier in this paragraph were combined into a theme of *student admission systems*. For more examples, refer to column four in Table 2. Further, we solicited feedback from the research team and two qualitative research professors on all study steps to enhance the quality and trustworthiness of the study planning, data collection, analysis, interpretations, and reporting. 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 (Saldaña, 2021).

Table 2. *Example of the analytic process for data excerpts*

Participants	Interview excerpts	Preliminary codes	Themes (codes)
Biftu	... As I grew up, ¹ I developed an interest in civil engineering-related jobs like construction works and building diverse roads. Deep inside, I like doing such jobs and activities. I was wishing them. ² From the very beginning, my interest was not only to major in engineering, ³ but also in civil engineering ... I scored a great GPA, ⁴ chose civil engineering as my first choice, and I got it. Thus ... ⁵ I view the discipline as mine.	¹ Interest in Civil Engineering jobs ² Interested in Engineering ³ Interested in Civil Engineering	Sense of belonging in Engineering (1, 2, 3, 5, 6, 7)
Rom	... My dad has a high passion for education. He makes a big effort to educate his children. His interest is as I achieve big things in education. I started and completed my primary and secondary education in the countryside, where I was born. Afterward, I attended a preparatory class where my brother works. I have an interest in education, ⁶ I have a particular interest in studying Health Sciences. ⁷ I was studying Biology. I have a high grade in it as well. I was studying Biology since I have an interest to join Health Sciences. ⁸ However, they [MOE] assigned me to a	⁵ Civil Engineering is mine ⁶ Interested in health science majors ⁷ Like Biology ⁴ Civil Engineering is my first choice ⁸ MOE assigned to	

	discipline, I didn't choose without my interest. ⁹ They gave me my 5th choice university.	Civil Engineering	systems (4, 8, 9)
Lidia	... In my opinion, ¹⁰ men and women peers are more open to each other than women and women ... The relationship I have with women's peers is average ... ¹¹ I easily fit in with men peers ... The other reason is that women's peers have jealousy, thus I do not have a great relationship ... For me, men peers are more positive. When they help me, they openly discuss their ideas when I ask them questions. ¹² Regarding faculty, I more openly relate to my women faculty, than my men faculty, to the extent that the women faculty provides me with advice ...	⁹ Study at 5th choice university ¹⁰ Had more interactions with men peers ¹¹ Prefer men peer interactions over women ¹² Had women faculty interactions [rather] than men's	Interactions with peers and faculty (10, 11, 12)

Limitations

Some participants experienced intermittent communication during the interview due to poor network connection, and additional data were collected through structured email for some sections of interview protocols that were not fully covered during the interviews. A structured email interview is one of the qualitative inquiry and research design approaches used to collect intensive qualitative data when the inadequacy of video data collection is experienced (Fritz & Vandermause, 2018). In future research, it would be helpful to conduct interviews locally and in person so that there is no issue with internet connectivity.

We believe that it would strengthen this study to include Ethiopian women researchers as part of the research team. Because we did not have any connections with Ethiopian women researchers, we leveraged the expertise and experiences of the two US-based women researchers in this study. Yet we acknowledge that the direct experience and nuanced and in-depth understanding and appreciation of the issues faced by the target population as experienced by Ethiopian women researchers/faculty members in engineering education is still missing. In future work, we would like to collaborate with Ethiopian women researchers who are interested in similar research areas.

Positionality, credibility, and trustworthiness

The research team member comprised of two Ethiopian men and one American women. The first author, Jemal, is a Black man is was also a senior doctoral student in engineering education. The second author, Sultan, is also a Black man, specialising in civil engineering, and is a faculty member and department head at Bule Hora University in Ethiopia. The third author, Nadia, is a white woman, an engineering education professor and the advisor of Jemal. She is also a scholar, with her research agenda involving diversity, equity, and inclusion-driven academic research efforts.

All three research team members had studied and/or researched engineering education and shared commitments to equity and justice in education. Each of the research team members also shared elements of identity with the study participants and thus could relate to the research topic, which together provided a starting place for intuitive knowledge, and enhanced understanding and interpretation of the experiences of the study participants (Secules et al., 2021). Accordingly, the woman co-author shared aspects of their gender identity with the participants and could share associated women's experiences in higher education during data analysis, although they had not experienced higher education in Ethiopia. The two Black men shared nationality, ethnicity, trilinguality, and having a major in an engineering discipline. They both had studied engineering, taught engineering, served as engineering department heads, and conducted research at one of the public universities in Ethiopia. They also had a sister who had studied engineering (bachelor's degree) and was pursuing a master's degree in engineering. As siblings who had close contact with their sister in supporting her in her academic pursuit, they were aware of the struggles women in Ethiopia could face in higher education, especially in engineering. Furthermore, the diversity in the researchers' identities, expertise, and experience enhanced the reflectiveness of the research process. For instance, while the two Ethiopian-origin men research team members enhanced the understanding of the Ethiopian context and men's perspectives in patriarchal Ethiopia, the US-based woman researcher facilitated our understanding of women's experience in engineering in the broader global context.

Findings

Women students were asked to discuss their educational experiences to explore their sense of belonging in the engineering major, college, and university; factors hindering and facilitating their sense of belonging; and how their perceived sense of belonging impacted their academic participation and experiences. The four themes that emerged were student admission systems, sense of belonging contexts, women student interactions with peers and faculty, and factors facilitating and hindering a sense of belonging. These themes are described in the following sections.

The impact of the student admission systems

During the interviews, students discussed whether the engineering major was their own choice or assigned by the Ethiopian Ministry of Education. The findings indicate that two of the participants, Biftu and Lidia, had selected their majors; however, Rom and Meto were assigned engineering majors by the Ethiopian MOE.

Biftu, who majored in engineering as her first choice, stated that growing up, she was inspired by engineering-related work and wanted to become a civil engineer one day.

Growing up, I became interested in civil engineering-related jobs like construction work and building diverse roads. Deep inside, I like doing such jobs. I was wishing for them. From the very beginning, my interest was not only in majoring in engineering but also in civil engineering ... I scored a great GPA, chose civil engineering as my first choice, and got it. Thus ... I view the discipline as mine (Biftu).

Here, the data suggested that Biftu had a strong passion for her major and pursued civil engineering with great dedication. Further, pursuing a major that aligned with her interests and goals could certainly offer her a positive sense of belonging regarding her study major.

Rom and Meto, assigned to engineering by the Ethiopian MOE, initially wanted to major in medical fields. Rom, interested in majoring in medicine or health, stated that the government assigned her to her engineering discipline and university.

No, engineering was not my choice. My choice was to study medicine or health officer.

Engineering was my 5th choice. The MoE assigned me to pursue engineering. Additionally, I was assigned to the university by the government (Rom).

Rom and Meto, assigned to engineering by the government, did not have the autonomy and agency to choose a major of their interest, hence, their future careers were selected for them by an external entity, the Ethiopian MOE. For instance, Meto indicated, 'Engineering was not my choice ... I wish not to identify with it. The root of engineering is physics, and I did not like physics, and due to that, I do not like engineering either.' The data indicate that Rom felt she had a partial sense of belonging, while Meto did not have a sense of belonging. Therefore, it is not surprising to learn that Rom and Meto struggled in their majors.

The impact of sense of belonging contexts

Students' sense of belonging on campus is crucial for success and persistence in their study programmes. A higher sense of belonging in the learning environment helps students feel respected and welcomed and enhances their confidence. During the interviews, the students discussed whether they felt a sense of belonging in their major, engineering college, and university. Through probing, they also disclosed reasons why they did or did not feel that they belonged in the major, engineering college, or university. This theme consists of three sub-theme contexts based on the student experiences and with which they had reflected their sense of belonging: 1) women students' sense of belonging in an engineering major, 2) women students' sense of belonging in an engineering college, and 3) women students' sense of belonging in the university.

Sense of belonging in the engineering major

Biftu and Lidia explained that they felt that they had a sense of belonging in an engineering major. Meto did not feel a sense of belonging in engineering, while Rom felt that she partially belonged. Biftu, who felt a sense of belonging in engineering, had an interest in the field from an early age, and that explains her sense of belonging in the major:

I decided to major in engineering since grade 7. I started focusing on courses that incline to have many calculations. Growing up, I became interested in civil engineering-related jobs like construction work and building diverse roads (Biftu).

Biftu, who had a clear interest in engineering from an early age, had a strong passion for civil engineering, and post-graduation engineering jobs. Meto, who felt that she did not belong in engineering, was assigned to the major without her interest and disliked engineering-related subjects, such as physics.

I do not like electrical and computer engineering. I wish not to identify with it. I was interested in health-related disciplines like biology. I never thought of majoring in engineering. The root of engineering is physics, and I did not like physics (Meto).

Here, Meto was admitted to electrical and computer engineering, a major that did not align with her interests and passions, which limited her sense of belonging.

The data suggest that autonomy and agency in choosing a major, and a sense of belonging in the major, aligned. For instance, Biftu majored in engineering and felt a sense of belonging in engineering. In the quote in the prior section, Biftu stated that she ‘was wishing [for] them [civil engineering jobs and activities]’ and continued, ‘Thus ... I view the discipline as mine’. This suggests that Biftu felt that she had autonomy and agency over choosing her major, and thus felt a sense of belonging in her major. On the other hand, Meto, who was assigned to engineering by the government and did not have autonomy and agency over choosing her major, felt that she did not belong in engineering. In the quote provided above, she said that she ‘wish[es] not to identify with it [electrical and computer engineering]’, indicating that she felt that this major was not her own choice, but was forced upon her. Having the agency to choose one’s major seems to have direct implications for having or not having a sense of belonging in the major: those who chose their major felt a sense of belonging in it, and those who were assigned to their major did not.

Rom felt a partial sense of belonging in civil engineering because her two older brothers had graduated in the major and encouraged her to pursue it. However, she did not feel that she belonged in engineering because she felt that working on remote sites was dangerous for women in Ethiopia.

The challenges are especially difficult for women in our country. The first reason is that most civil engineering works are in the field, for instance, road construction, bridge, railway engineering, and building engineering. For all these types of work, you have to go to the sites ... they are site-based jobs that make women vulnerable to different challenges. The second reason is most engineering works in our country are not supported by machinery ... it is done manually, leading to health and safety problems for workers. Thus, my interest in engineering is not that great (Rom).

Although Rom was assigned to engineering by the Ethiopian Ministry of Education, she felt a partial sense of belonging within civil engineering because her siblings encouraged her to persist. Yet she was alienated from civil engineering because, in Ethiopia, engineering jobs are primarily done on site (making women vulnerable), and engineering jobs are dominated by manual work. Thus, Rom believed that expected post-graduation work experiences, job stability, and satisfaction impacted her sense of belonging with regard to her major.

Sense of belonging in engineering college

Biftu and Meto felt they belonged in an engineering college, whereas Rom and Lidia felt a partial sense of belonging. Biftu felt a sense of belonging in the engineering college because of the freedom and social life, lack of discrimination, and conducive and well-equipped library to study in:

... I see it [engineering college] as my home. The reasons are freedom since it is a government university, the college is equal for all students, the social life in the university, and the rules and regulations equally apply to all, there were no discriminations ... The other reason ... sufficient books in its library, and no one disturbs you in the library (Biftu).

Thus, for Biftu, some elements of democracy and equality (freedom, absence of discrimination, rules applying equally to all, absence of others who disturbed her) were important determining factors for her sense of belonging in the engineering college.

Rom felt a partial sense of belonging in the engineering college. Lidia did not feel a sense of belonging in the college because of 'weak facilities and lack of technical and laboratory materials'. On the other hand, Rom felt some sense of belonging in the engineering college because of the college's larger goal – 'solving the community's problems'. However, she was alienated from the college because of its limited attitude and efforts towards addressing the quality of education, limited monitoring practices with regard to faculty teaching, and the college's inability to provide sufficient practical aspects of the courses, e.g., laboratory courses.

Sense of belonging in the university

Three of the participants felt a sense of belonging in the university, while Biftu felt a partial sense of belonging. The three participants had a sense of belonging in the university for different reasons.

For Meto, ‘It is where I gained life experience, where I started and completed my university education’. For Lidia, her university was a place with ‘lots of special friends and memories’. For Rom, the university was her first institution after her home high school where she met Ethiopian students from all over the country and from many ethnic groups. Interestingly, Meto was assigned to her major (unsurprisingly, she did not feel a sense of belonging in this regard) but felt a sense of belonging in the engineering college and university. This implies that students may have a different sense of belonging in various aspects of the engineering community; they may feel they belong in a major but not an engineering school or university.

Biftu, who felt a partial sense of belonging in the university, ‘... wanted to go to Addis Ababa University’ – Ethiopia’s most prestigious university – ‘because such big universities have sufficient laboratories and faculties; thus, I could get better quality education. But, unfortunately, this university hasn’t had many engineering materials’. Biftu did not feel a sense of belonging in the university because the university was not her first choice, and it did not have sufficient laboratories.

The impact of interactions with peers and faculty

We explored the interactions of women students with their peers and faculty to see if their interactions and gender mattered to their sense of belonging. This theme consists of two sub-themes: 1) interaction with peers, and 2) interaction with faculty.

Women student interactions with peers

Most of the participants – three out of four women students – had positive interactions and a sense of belonging with men peers. Biftu and Rom preferred interacting with male peers because they thought men were more open to sharing information, providing more support, and being more positive. Further, they believed women were less receptive and exhibited jealousy.

My relationship with male peers is great ... It is easier for men and women to interact; we can easily relate. There is this thing called ‘opposite charge attracts each other’. In my opinion, men and women peers are more open to each other than women and women ... Women too, than for other women, they are more open for men peers ... The relationship I have with women peers is average. Naturally, I easily fit in with men peers ... The other reason is that women peers have jealousy, thus, I do not have a great relationship ... they are not open. If you ask men and women

peers the same question, who answers for you first? Men. The reason is men are more open. For me, men peers are more positive. When they help me, they openly discuss their ideas when I ask them questions (Biftu).

At this point, Biftu suggests that women students with a high level of interactions with peers demonstrate a stronger sense of belonging, which is directly linked to helping the efforts of students to develop learning experiences in academic settings. While Meto did not have any preference for peer interactions, Lidia had negative interactions with men peers, as they underestimated women and ignored her in group activities, thus she preferred women peers.

It is very poor, interaction with my male classmates because most underestimate women in educational affairs. This makes me feel sad and embarrassed. ... Most males ignore us in participating teams. I prefer belonging to my woman classmates ... It makes me feel good and motivated to perform better (Lidia).

Lidia's negative experience with men peers underestimating her intelligence in engineering matches the stereotypes in Ethiopian society; lower expectations for women, especially in engineering (Trines, 2018), which shows the persistence of the same stereotype across time and culture: that engineering is a masculine profession.

Women student interactions with faculty

Biftu and Rom had positive interactions with male faculty. However, Biftu preferred female faculty members as she thought they were more open to help and discuss whatever she wanted without fear because of gender similarity.

I more openly relate to my women faculty than my men faculty, to the extent that the women faculty provide me with advice. For example, I have a close relationship with Professor Leensee [pseudonym, her favourite women professor] ... My relationship with her goes beyond the classroom and extends to her office, where I ask questions beyond the classroom. I admire the way she taught us. She is often willing to entertain our questions. I prefer women faculty. You can openly ask women faculty whatever you want because we both are the same sex ... I am not afraid of talking to them. Men faculty, however, we respect them, but I also fear them ... we women students are afraid of talking about whatever we want with them. You have to be cautious when you establish your relationship with men teachers, you have to ask just about academics (Biftu).

In the above quote, Biftu had more open and extended positive experiences with women faculty as they shared more elements of identity. She suggested how she, as a women student, needed to be cautious around men faculty.

In contrast, Rom preferred male faculty members because she thought men took more time to provide support academically, for instance in tutorial classes. ‘Men faculty ... give us more time to support us. On tutorials for women students, men faculty, most of the time take their time and provide us tutorial classes more than women faculty’ (Rom). Rom described more positive experiences with male faculty members, suggesting the subjective experience of women students with faculty of a different gender.

To build a sense of belonging and educational experiences, the sameness in the gender of a faculty member is essential for some students; for instance, Biftu preferred women faculty members to be able to openly communicate even beyond academic matters, while for Rom, the level of support faculty offers mattered more than their gender identity, and she preferred male faculty. On the other hand, Meto could not make any gender preference as she had only had one woman teacher in her five years at the university.

Factors facilitating and hindering a sense of belonging

We also analysed factors that could facilitate or hinder students’ perceptions of a sense of belonging. Accordingly, the data suggest that the choice of major by the admission system, the status/prestige of the university, the gender identity of peers and faculty, and the provision of support affect the students’ sense of belonging. Selecting a major and pursuing engineering according to one’s interest, as was the case with Biftu, who ‘decided to major in engineering since grade seven and made it her goal to major in engineering’, seemed to enhance her sense of belonging in engineering, in contrast with Meto and Rom, who did not feel they belonged in engineering as they were assigned their majors by the Ethiopian MOE despite medical sciences being their first choice.

The status of the university, its prestige and level of resources, also affected sense of belonging. For instance, Biftu did not feel a sense of belonging in the university because her first choice was Addis Ababa University, the Ethiopian flagship, and a well-resourced university. Not only Biftu – most participants had a limited sense of belonging in the university due to limited facilities,

especially laboratories, thus limited ability to facilitate practical aspects of their courses. They were thus obliged to do laboratory applications in other universities.

The preferred gender of faculty depended on the context. With peers, Biftu and Rom preferred to have men peers, but with faculty, Biftu preferred women because she believed she could talk without fear about anything, including advice beyond the academic. In contrast, Rom preferred male faculty because she thought they took more time to support and ‘provide tutorial classes more than women faculty’ (Rom). It should be noted, however, that most of the women participants indicated that they had to be ‘cautious’ with men peers and faculty and focus on academics due to the prevalence of sexual violence, the university’s limitations in enacting gender violence policies, and instance of advances from some faculty to exchange high grades for sexual favours. That is why Lidia (one of the study participants) recommended that ‘there should be strict laws and regulations ... preventing...harassments for all university students and workers’.

Discussion

The students were aware of the importance of having autonomy and agency in choosing their major and university and how this affected their sense of belonging in their major, engineering college, university, and academic experience. Our findings align with a study by Murtagh et al. (2011) who found that students feel a greater sense of belonging and satisfaction when they make decisions about major choices and careers based on intrinsic motivations than when being forced by external agencies.

Another insight from the analysis is that the effect of a student feeling a sense of belonging (or not) to an engineering major, college, and university is not necessarily parallel. A student may feel they belong in their major but not in an engineering college or the university. This suggests that students who feels they belong in a major may still have a different feeling of belonging in an engineering college or university and vice versa. Hurtado et al. (2007) similarly found that students’ sense of belonging in their major was associated with positive feelings about their learning experiences, even though they did not have a consistent correlation with their sense of belonging in the learning institutions.

Similarly, various students viewed the same thing differently. For instance, Biftu viewed the engineering college as having a conducive and well-equipped library, and this was one of the factors that made her feel a sense of belonging at engineering college. Yet, Lidia viewed the engineering college as having ‘weak facilities and lacking technical and laboratory materials’. Thus, among the factors, she did not feel a sense of belonging with regard to the college. At this point, there was a diversity of ideas and preferences around when women students chose a major and university, or on values whereby they prioritised a sense of belonging. If given the agency and freedom to choose a major and/or university, a woman may value different components of the university. Some women students may prefer to join a university that offers an enjoyable student life, while others may want to forgo the student life and instead study a major of their choice. Such freedom and agency may enhance a sense of belonging, inclusivity, and satisfaction. Also, engineering colleges may need to be conscious of variations in students’ values and expectations of standards and aim to address the needs of as many students as possible. In doing so, engineering colleges may need to explore and compile common factors, reasons, and values that make many students feel that they do or do not have a sense of belonging within engineering colleges and sustain the elements many students find important for an enhanced sense of belonging (Halkiyo et al., 2023).

Regarding gender preference with regard to building learning experiences, the participants’ interactions with peers and faculty were nuanced and pragmatic. Their gender preference seemed to depend on women students’ personalities and individual experiences, teachers’ enthusiasm and willingness to support students, and gender identity, and these factors had diverse impacts on sense of belonging. This indicates that gender is not static and gender preference differs between peers and faculty, depending on who provides more support in a particular situation and what is important for women students. This is consistent with findings in the literature that an individual’s sense of belonging changes based on situations; ‘thus, a student with a high sense of belonging in a certain educational context can have a low sense of belonging if they move into a different educational context’ (Lee et al., 2019, p. 3).

It should, however, be noted that women students in Ethiopia know that ‘sexual harassment is endemic across universities in Ethiopia and affects the psychological, emotional, and physical well-being of women’ (Sidelil et al., 2022, p. 2). These students felt they had to be cautious around

men students and faculty because sexual violence (e.g., sexual harassment, attempted rape, and rape) is common and persistent in Ethiopian higher education institutions (Adinew & Hagos, 2017). Male instructors engage in sexual advance as an exchange for better grades, or threaten to give bad grades (Bezabeh, 2016), and the universities do not do much to prevent sexual violence. Students also know that ‘male academics force female students to comply with their sexual demands ... may threaten students with their grades; others bribe students with grades to advance their sexual interests’ (Sidelil et al., 2022, p. 208). Despite women students calling for stronger and applicable gender violence-related laws, most universities fail to make violators accountable for their actions. This indifference and lack of action from the university side continue to lead to the persistent and unintended perpetuation of gender violence. Sidelil et al. (2022) argue that ‘the high prevalence of sexual harassment in universities is perpetuated by institutional actions and inactions through which universities fail to proactively prevent and effectively respond to sexual harassment’ (p. 1).

Implications

The findings of this study have some implications for policy, practice, and research. First, the Ethiopian government and policymakers at the MOE make two contradictory policy assumptions. On the one hand, the Ethiopian MOE is increasing the number of students in engineering disciplines to assist with transforming Ethiopia from an agriculture-oriented to an industry- and manufacturing-oriented middle-income country. At the same time, the government wants to reduce the attrition rate of women students and to have competent engineering graduates who will help transform the country. Against this, however, the Ethiopian MOE is also engaged in assigning some women students to engineering disciplines and universities against their interest. This diminishes women students’ sense of belonging in their major and university, which may hinder their participation, experience, and performance, leading to increased attrition. Thus, the government should revise these contradicting policy choices and allow the autonomy and agency of women students to major in the discipline of their choice, hence, in the profession they want to pursue after graduation.

The practitioners, university faculty, and leadership may provide additional academic and social programmes to enhance the sense of belonging of women students in engineering, mainly

tailored to those who have been assigned to a discipline and university not of their choice. Moreover, until women students feel safe in the university and do not have to deal with the threats of sexual violence, it will be near impossible for women students to truly experience a sense of belonging. This study confirms prior findings that point to systemic issues of sexual violence in universities.

Conclusion and future work

The importance of allowing Ethiopian women students in engineering to have the autonomy and agency to choose a major and/or the university of their choice is manifold: it enhances their motivation to learn, helps them to persist, improves their university experience and academic performance, increases the chance of staying in the profession after their graduation, and improves their sense of belonging in their major, engineering college, and university. However, in addition to the agency and freedom to choose one's major and/or university, the students' sense of belonging was also affected by additional factors such as (1) the presence or absence of sufficient engineering resources (e.g., laboratories and library services), (2) gender identity of peers and faculty, and (3) openness and willingness of faculty to support women students.

The Ethiopian government and universities should note that a woman's positive sense of belonging in a major does not necessarily translate to a positive sense of belonging in an engineering college or university. The findings suggested that women students could feel a sense of belonging in their major but not the engineering college. Women students could have the autonomy to major in the discipline of their choice, yet they might not have a positive sense of belonging in the engineering college and/or university. Similarly, just because a woman student does not feel she belongs in her major (if assigned by the government), it does not necessarily mean she also dislikes her engineering college and/or university. The women students were more nuanced and pragmatic; for instance, they might still have a positive sense of belonging in an engineering college and/or university if it was equipped with enhanced engineering resources and a conducive learning environment free of gender violence. A similar situation was true regarding gender preference. While the gender (of peers and faculty) mattered to some, the enthusiasm and willingness to support women (despite their gender) mattered for others.

What is more concerning in this finding was that the government assigned two of the four women students to the discipline and the university against their interests. This was not only damaging in hindering the women's sense of belonging and associated benefits but also it is counterproductive to the effort universities make to increase the retention, persistence, and achievements of female students. Thus, the engineering college, university, and the government of Ethiopia may need to prioritise making engineering a safer and more inclusive space prior to forcing more women into this area of study because making these spaces more inclusive makes women more likely to stay in engineering. Furthermore, in addition to considering hiring more women faculty, Ethiopian universities may want to infuse professional development opportunities that enhance ethics, professionalism, and democratic culture (especially for men students and faculty). Above all, the government of Ethiopia should not infringe on the agency and autonomy of women students in choosing their major and/or university. Ethiopian women students are capable of making pragmatic decisions: what to study, where to study, what values they prioritise, and what they want to forgo.

In future work, we believe that it would be beneficial to consider how sense of belonging impacts Ethiopian women engineering students' future career aspirations and their completion of their undergraduate degrees. Sense of belonging may help us better understand not only their current situations, but also their future conceptions of themselves. It would also be beneficial to have a larger scoped study that considers other possible influences of women students' academic participation, experiences, and successes.

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Dedication

On behalf of the researchers, we dedicate this research work to Bedane Halkiyo Anata (father of the first and second authors), who believed in wisdom, and in the power of education in dismantling backwardness and transforming one's life for good. Thank you for affording us (your children) the opportunity you did not get yourself – education!

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Appendix: interview protocol and probing questions

1. How would you describe your education journey?
2. Was engineering your first choice?
 - A. If so, what made you decide to major in engineering?
 - B. If not, who assigned you and why?
3. Do you feel a sense of belonging in engineering?
 - A. If so, why do you feel a sense of belonging in engineering? Could you give me an example of when you do feel a sense of belonging in engineering?
 - B. If not, why? Could you give me an example of when you do not feel a sense of belonging in engineering?
4. Do you feel you belong in the engineering college?
 - A. If so, can you tell me a time when you felt a sense of belonging in engineering? Why did you feel a sense of belonging in college? Could you give me examples of when you do not feel a sense of belonging in your engineering college?
 - B. If not, can you tell me a time when you didn't feel a sense of belonging in engineering? Why didn't you feel a sense of belonging in college? Could you give me examples of when you do not feel like belonging in an engineering college?
5. What does your interaction look like with men peers?
 - A. Please explain. Could you give me an example?
6. What does your interaction look like with your female peers?
 - A. Please explain. Could you give me an example?
 - B. Which gender (men or women classmates) do you feel a good sense of belonging with in engineering? Why?
7. What does your interaction look like with men faculty?
 - A. Please describe. Could you give me an example?
 - B. What is the number/quantity of faculty/teachers you took engineering courses with? Men teachers: _____ Women teachers number: _____
8. What does your interaction look like with women faculty?
 - A. Please describe. Could you give me an example?

- B. Which gender (women or men faculty) do you feel a better sense of belonging with in engineering? If women, why? If men, why?
- 9. Do you feel you belong in [name redacted] University?
 - A. If yes, why?
 - B. If no, why?
- 10. How do you think having a sense of belonging impacts your academic participation?
 - A. Please describe. Could you give me an example?