Belonging and Inclusion in STEM: A Mixed-Methods Study Reveals Challenges for Self-Identified Neurodivergent Students in an Australian University

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Abstract

Students' sense of belonging in Science, Technology, Engineering, and Mathematics (STEM) education is widely recognised as critical to academic engagement and success. This study reports on a survey of undergraduate science students (N = 312) at a large Australian university, examining their feelings of belonging and inclusion in the Bachelor of Science program. A mixed-methods approach was employed, combining quantitative measures of belonging (14 validated scales, reduced via factor analysis to Passive Belonging and Active Engagement dimensions) and qualitative open-ended responses about students' inclusion experiences. Results indicated generally high levels of belonging, with Active Engagement rated higher (M = 4.18, SD = 0.59, scale ranged from 1-5) than Passive Belonging (M = 3.75, SD = 0.69), and infrequent experiences of incivility. No significant differences in belonging emerged across most demographic groups, although neurodivergent students reported poorer active engagement on average. Thematic analysis of 482 written comments revealed potential barriers and facilitators at the university, interpersonal, and individual level that each shape students' sense of inclusion. Neurodivergent students were overrepresented among those citing interpersonal and structural barriers. These findings provide insight into the current climate of inclusion in STEM and inform strategies—such as enhancing instructional design, faculty training, and peer support—to foster a stronger sense of belonging for all students.

Introduction

A strong sense of belonging and inclusion plays a key role in student engagement and academic success in higher education (Osterman, 2000; Slaten, Ferguson, Allen, Brodrick, & Waters, 2016). A sense of belonging and inclusion in an educational context refers to students' feelings of being accepted, valued, and encouraged by others in the learning environment (Goodenow, 1993). Students with a strong sense of belonging tend to demonstrate higher academic motivation, achievement, and well-being (Korpershoek, Fokkens-Bruinsma, & de Boer, 2020; Slaten, Ferguson, Allen, Brodrick & Waters, 2016; Winstone, Balloo, Gravett, Jacobs & Keen, 2022). A sense of belonging has also been linked to improved retention and enrolment continuity (Suhlmann, Sassenberg, Nagengast & Trautwein, 2018), especially for students from marginalised or underrepresented groups

(Pedler, Willis & Nieuwoudt, 2022; Strayhorn, 2011). It is therefore critical that educators create learning environments where all students—regardless of gender, culture, neurodiversity, disability, or other background factors—feel that they belong and can succeed.

Despite the importance of belonging, research suggests that not all students feel a sense of belonging in science, technology, engineering, and mathematics (STEM) subjects (Rainey, Dancy, Mickelson, Stearns, & Moller, 2018). One group who reportedly experience reduced belonging and inclusion in STEM, and for whom there are ongoing improvement efforts nationally (Department of Industry, Science and Resources, 2024), is women. Previous research reports that women describe STEM learning environments as unwelcoming or exclusionary, often citing experiences of bias, marginalisation, or feeling out of place in male-dominated classrooms (Good, Rattan & Dweck, 2012; Smith, Lewis, Hawthorne & Hodges, 2013). These experiences can contribute to poor confidence, reduced participation, and a diminished sense of belonging for women compared to men (Blackburn, 2017; Cheryan, Ziegler, Montoya & Jiang, 2017). In STEM disciplines which may be 'gender-balanced' (e.g. chemistry and biology; Cheryan et al. 2017), a stronger science identity in women is still associated with their persistence in science degrees and careers, and women continue to report some experiences of exclusion or marginalisation (Fisher, Thompson & Brookes, 2020). They also report lower levels of belonging in their first year compared to male counterparts (Fisher, Thompson & Brookes, 2022).

Beyond gender, students from other marginalised or underrepresented groups—such as students who are culturally and linguistically diverse (CALD), first-generation, neurodiverse, and those with disabilities—also report feelings of isolation in STEM programs (Alston & Hampton, 2000; Dika & D'Amico, 2016; Dunn, Rabren, Taylor & Dotson, 2012; Graham, Kogachi & Morales-Chicas, 2022). For example, disabled students report that STEM educators are not well prepared to support their learning through accommodations to existing course design (Chasen, Borrego, Koolman, Landgren, & Chapman Tripp, 2025). Similarly, neurodivergent students report feeling pressure to conform to neurotypical norms in STEM environments. Australian neurodivergent students indicated that their participation and belonging are hindered by ableist curricula, stigmatisation, stringent communication expectations, the absence of sensory spaces and the absence of neuro-affirming peer environments (e.g., student clubs or associations, Butcher & Lane, 2024). Consequently, neurodiverse cohorts may not persist to graduation (Accardo, Kuder & Woodruff, 2019; Bailey, Frost, Casagrande & Ingersoll, 2019). Collectively, underrepresented students may experience systemic barriers, cultural disconnection, or a lack of visible representation, all of which can erode their sense of belonging (Rainey et al., 2018).

Despite poor perceptions of belonging among some student populations, a growing body of research suggests belonging can be improved through social and educational interventions, particularly among underrepresented groups (Ramsey, Betz & Sekaquaptewa, 2013; Walton & Cohen, 2011). Interventions which increase belonging—such as peer mentoring, structured learning communities, and social-belonging exercises—have also shown promise in reducing achievement gaps and improving academic outcomes for these students (Andrade, 2007; Gehreke, Schilling, & Kauffeld, 2024; Glaser, Hall, & Halperin, 2021; Murrar, Campbell, &

Brauer, 2020). For example, a social-belonging intervention improved both perceptions of belonging and academic performance for CALD students (LaCosse, Canning, Bowman, Murphy, & Logel, 2020). These interventions are important because they offer educators an opportunity to improve perceptions of belonging among underrepresented students, which can then improve their academic engagement.

Although there is evidence that interventions can improve student experiences within educational environments (Mertens, Deković, Leijten, Van Londen, & Reitz, 2020), it is important that those interventions are developed with the local context in mind. The present study responds to this need by capturing the voices of students within an Australian STEM program, offering context-specific data to inform the development of meaningful belonging interventions in the Australian context.

This study examines perceptions of belonging and inclusion in STEM at a large Australian university. Prompted by broader institutional post-pandemic initiatives to value student-voice and begin the co-creation of socially connected, well-being supportive learning environments, we conducted a mixed-methods study to assess students' experiences in a Bachelor of Science (BSc) program. The aims of this project were to: (1) measure students' sense of belonging and active engagement in their STEM studies; (2) identify any demographic or experiential factors associated with lower belonging or inclusion (i.e., potential risk factors); and (3) explore the barriers and facilitators of belonging as described by students themselves.

Based on previous research we hypothesised that women and gender diverse students would report a lower sense of belonging compared to men. We also conducted exploratory analyses to determine the effects of other demographic characteristics on belonging, namely: sexuality, neurodiversity, first generation status, English as an additional language, and relative socio-economic advantage (operationalised through student post codes). Finally, our qualitative analysis sought to answer the question, 'what enhances and limits student experiences of belonging within the classroom and broader university context?'.

Methods

Participants and Procedure

Participants were undergraduate students enrolled in the Bachelor of Science (BSc) degree at the University of Melbourne in 2024. In March–June 2024, all BSc students were invited via email, learning management system announcements, university and student-run social media channels, and posters around campus, to voluntarily complete an online survey about their sense of belonging and inclusion within their degree. The survey was anonymous and took approximately 15 minutes to complete. A total of 312 students responded (approximately 5–10% of the total BSc enrolment). The study protocol was reviewed and approved by the University of Melbourne's human research ethics committee (Ethics Project ID: 28429). Participant demographic information can be found in the Supplementary Materials.

Measures

Demographic information and enrolment details (major, domestic/international status, first-in-family to attend university, study load, and whether studying in-person or online) were collected to examine potential factors related to belonging.

Students also completed 14 scales/sub-scales assessing their experiences in the university environment, including perceptions of peer and faculty relationships, self-efficacy, and university culture. An exploratory factor analysis of 14 belonging-related scales identified two factors—Passive Belonging (perceptions of a fair, inclusive, and supportive environment) and Active Engagement (personal engagement, participation, and self-efficacy)—accounting for 57.1% of variance. Incivility was treated as a standalone outcome due to its negative valence and low mean, and one sub-scale (university affiliation) was excluded as it did not load clearly on either factor. Details can be found in the Supplementary Materials.

Finally, the survey included two open-ended questions: (1) "Do you feel included in your classes and/or major? Why or why not?" and (2) "Beyond the classroom, where at university do you feel a sense of belonging (or not)?" These questions invited students to describe in their own words the factors that helped them feel included or caused them to feel excluded.

Data Analysis

Descriptive statistics were computed for all key measures. Bivariate Pearson correlations (See Table 1) were examined between the demographic variables (gender, sexuality, neurodivergence, disability, first-generation status, English as an additional language, and socio-economic index of advantage/disadvantage for home and current postcodes) and the outcome measures (Passive Belonging and Active Engagement composites). We also conducted three linear regression models; see Supplementary materials for model specification and detailed results.

For the qualitative data, we employed an inductive coding approach to analyse responses to two open-ended survey questions about students' experiences of belonging and inclusion. The lead author conducted an initial review of all written comments and developed a preliminary set of codes grounded in the data. A second author independently reviewed the codes and associated responses, providing feedback and suggesting revisions in areas of disagreement. Discrepancies were resolved through collaborative discussion. The lead author then re-read the full dataset to ensure consistency and completeness, adding or refining codes where necessary.

Following the inductive process, the research team collaboratively developed a thematic framework to organise the data, settling on a framework that categorised barriers and facilitators of belonging within three levels: (1) *University-level* factors (institutional or structural aspects of the program and campus environment), (2) *Interpersonal-level* factors (interactions among peers and the social climate), and (3) *Individual-level* factors (personal circumstances or dispositions of the student). Each response could be coded into multiple categories if it mentioned several distinct issues. After coding all responses, we counted the frequency of each theme and examined exemplary quotes. We analysed responses from

neurodivergent students in further detail by comparing the proportion of neurodivergent students contributing to each theme to their proportion in the sample (~20%). This allowed us to see whether any themes were disproportionately raised by these participants and therefore whether certain barriers or facilitators may be particularly salient for the neurodiverse group.

Results

Descriptive statistics

For the whole sample, participants reported high levels of belonging and inclusion, with higher active engagement ($M = 4.18$, $SD = 0.59$) compared to passive belonging ($M = 3.75$, $SD = 0.69$). Incivility was infrequent across the full sample ($M = 1.65$, $SD = 0.77$). As shown in Figure 1, although most students experienced low incivility, some individuals still experience high rates in the university setting.

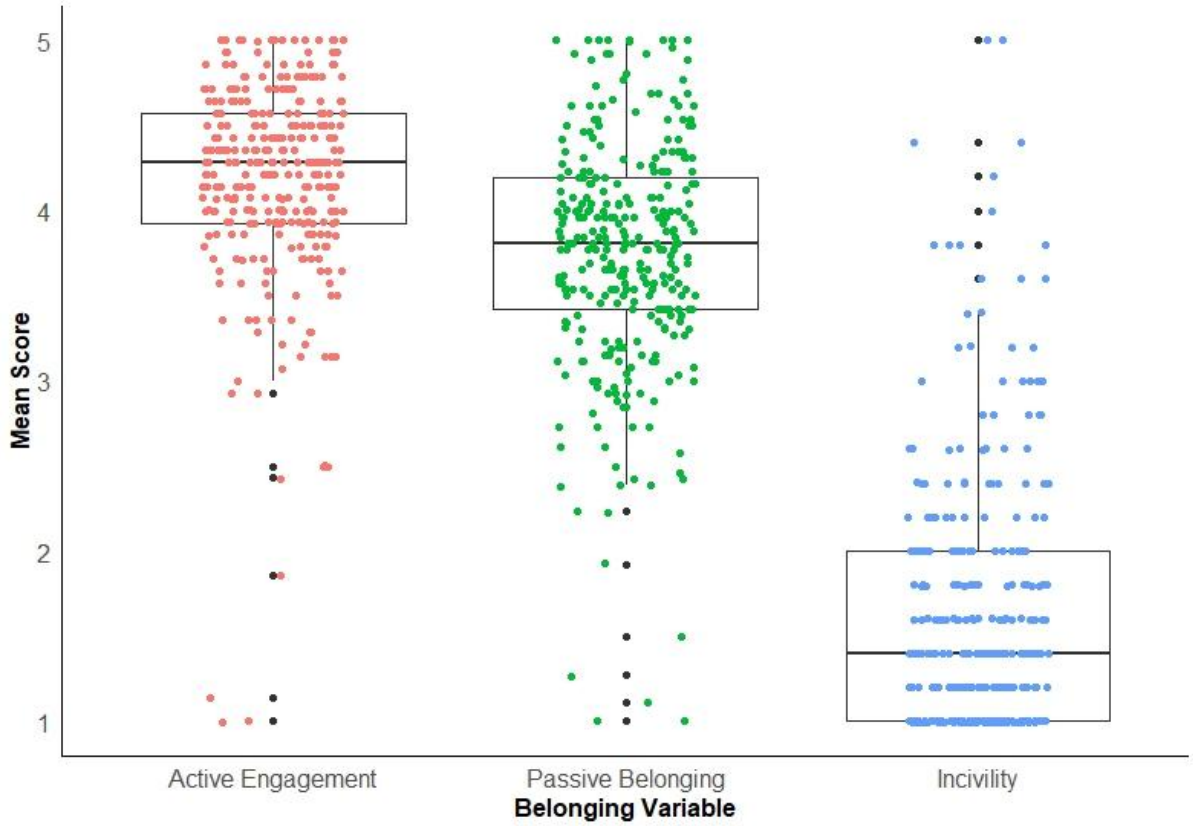

Figure 1. Box plots indicating raw scores for active engagement, passive belonging, and incivility for the full sample

Table 1 shows bivariate correlations between demographic characteristics and the two composite outcome variables (Passive Belonging and Active Engagement). Participants who self-reported being neurodivergent or having a disability were more likely to also identify as a sexual minority, compared to able-bodied and neurotypical participants. English as an additional language (EAL) students were more likely to be first generation students, compared to students who speak English as a first language. Finally, the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD; Australian Bureau of Statistics, 2023) for home and current post-codes were also positively correlated (i.e., if you lived in a high

IRSAD post code in your family home, it was more likely that you currently live in a high IRSAD post code, possibly even the same house). See Table 1.

Table 1. Bivariate correlations between predictor variables and belonging outcomes (Passive Belonging and Active Engagement)

	Passive Bel.	Active Eng.	Sexual Minority	Neurod.	Disability	First Gen.	EAL	Current IRSAD	Home IRSAD
Passive Belonging	-	.670**	-0.026	-0.148*	-0.092	0.058	0.106	0.013	0.093
Active Engagement	.670**	-	-0.099	-0.161*	-0.077	-0.006	0.036	-0.004	-0.076
Sexual Minority	-0.026	-0.099	-	.376**	.252**	0.045	0.059	0.092	0.017
Neurod.	-0.148*	-0.161*	.376**	-	.437**	-0.047	-0.002	0.131	0.049
Disability	-0.092	-0.077	.252**	.437**	-	-0.07	-0.016	.172*	0.055
First Gen.	0.058	-0.006	0.045	-0.047	-0.07	-	.235**	-0.057	-0.195*
EAL	0.106	0.036	0.059	-0.002	-0.016	.235**	-	0.054	-0.065
Current postcode	0.013	-0.004	0.092	0.131	.172*	-0.057	0.054	-	.551**
Home postcode	0.093	-0.076	0.017	0.049	0.055	-0.195*	-0.065	.551**	-

Note. Correlations marked with ** are significant at $p < 0.01$, and * at $p < 0.05$. Passive Belonging and Active Engagement are composite scores as described in text. "Neurod." = Neurodiversity. "EAL" = English as an additional language. "First Gen." = first generation in family to attend university. "IRSAD" = Index of Relative Socio-economic Advantage and Disadvantage, based on postcode; higher values indicate higher advantage.

Neurodivergence was the only demographic variable that showed a statistically significant negative correlation with both passive belonging and active engagement (see Figure 2).

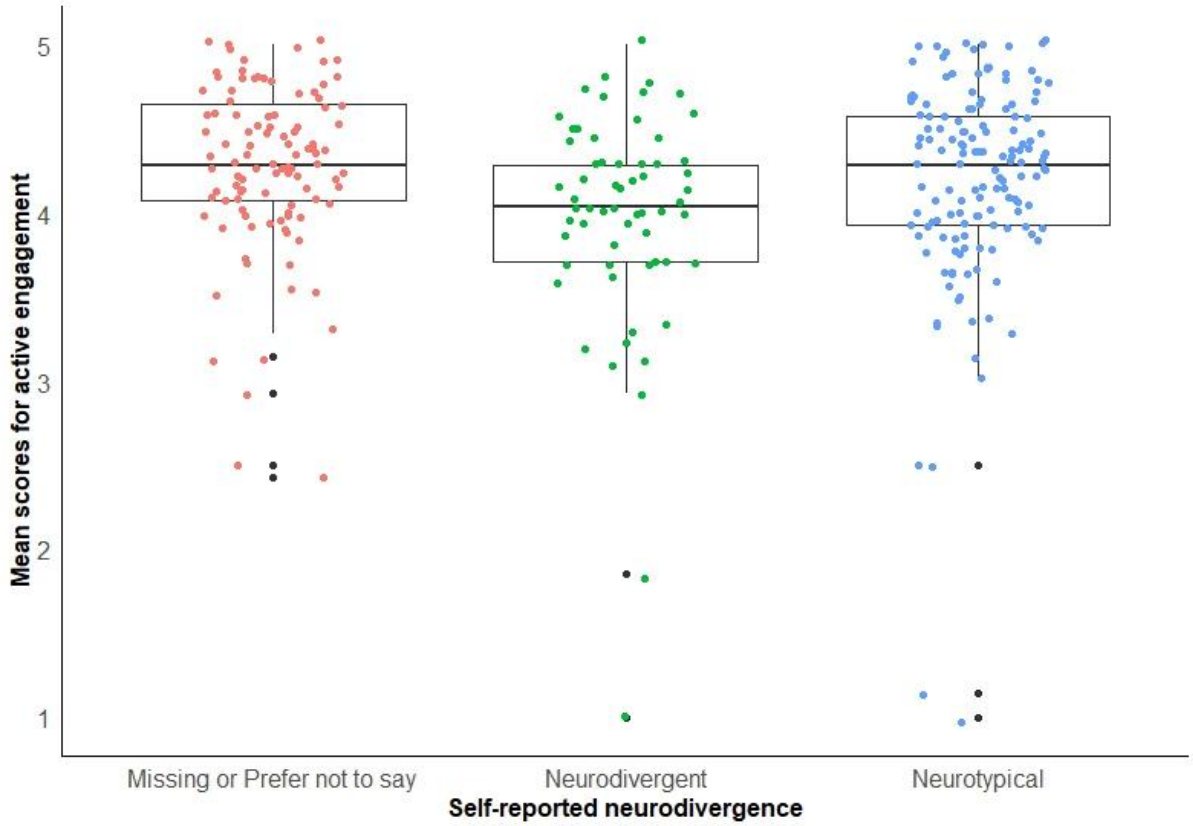

Figure 2. Raw scores for active engagement for neurodivergent and neurotypical participants

Inferential statistics

Across all three regression models, individual-level variables did not significantly predict passive belonging, active engagement, or incivility, and none of the individual predictors were significant. Model fit was poor in each case ($R^2 = 0.045–0.067$), indicating that these variables explained little variance in the outcomes. These findings suggest that factors beyond those included in the models are likely to play a more substantial role in shaping students' perceptions of belonging, engagement, and experiences of incivility.

Qualitative Results

In this final section we qualitatively review responses to questions about belonging inside and outside the classroom. We provide a framework for understanding barriers and facilitators of belonging, identified at the University, interpersonal, and individual level. Overall, students were more likely to describe features of the environment that enhanced their perceptions of belonging (233 datapoints), though several barriers were also identified (159 datapoints). For each level, we report the proportion of comment segments that referenced a particular barrier or facilitator (rounded to the nearest percentage point) to indicate the relative prominence of each theme. These frequencies are intended to support interpretation rather than to imply statistical generalisability. To provide further context, we include each participant's gender and major discipline following quoted responses.

Barriers to belonging

University level ~ 16% of comments

Factors within this code relate to structural and systemic features of the university environment. The most common concern raised by students was that the degree felt impersonal, primarily due to the size of the university and BSc cohort (e.g., "the classes are too big and it is difficult to form meaningful connections" [woman, engineering]). Students also felt that poor class design led to low student participation and engagement (e.g., "I think it is very easy in my classes to be like a 'fly on the wall', so as to not really engage, […] When I am at class, I want there to be something which helps me to engage" [man, biosciences]). Finally, negative faculty interactions led some students to believe that teaching staff are not invested in student experiences (e.g., "The university doesn't have an amazing reputation when it comes to its student and staff relations, especially when intersectionality and culture is involved" [man, science]).

Interpersonal level ~ 11% of comments

Factors within this code capture peer-to-peer challenges that reduce opportunities for belonging and inclusion. Students frequently reported that existing 'cliques' and friendship groups can make it difficult to form new connections (e.g., "many students already [from] Melbourne with existing friendships [aren't] engaged in attaining more" [woman, engineering]). Other interpersonal challenges include differences in personality, values and other socio-emotional challenges (e.g., "Some students like to make themselves seem more superior" [woman, biomedicine]). Finally, language barriers present a challenge for both domestic and international students (e.g., "It's also difficult with international students as they speak Chinese and leave you out of conversations" [man, biomedicine]).

Individual level ~ 13% of comments

This final code highlights individual challenges that make it difficult for some students to feel connected to the university and others. For instance, students living a long distance from campus mention that it is difficult to engage with events and to form strong networks due to their commute (e.g., "events generally take place later in the day, [making] it difficult for people who live away from campus to take part" [man, mathematics]). Students who identify as minorities within the classroom often felt that they couldn't express themselves and therefore struggle to connect with others (e.g., "I feel very excluded being a woman as I feel I can't express my ideas or opinions as men will often ignore it or just say it's wrong" [woman, mathematics]). Finally, some students report self-doubt and imposter syndrome, relating to both the content and their place on campus (e.g., "I don't feel smart enough for this university" [man, undecided major]).

Facilitators to belonging

University level ~ 10% of comments

This level describes characteristics of the BSc that improve perceptions of belonging and inclusion. Strong class design, particularly those that encourage student communication and discussion, was consistently valued (e.g., "I think class discussions really help to foster a sense of community" [woman, agriculture]). Similarly, students enrolled in majors with a consistent cohort (or one that is relatively small) allows them to reconnect with the same students (e.g., "I feel a lot more included in my classes with smaller cohorts than larger ones"

[woman, engineering]). Counter to negative interactions with staff, positive faculty interactions improve perceptions of belonging by providing a supportive and encouraging environment (e.g., "tutors make sure to go around the room and talk to everyone about their ideas, so it makes you feel included and your opinions valued" [woman, biomedicine]).

Interpersonal level ~ 44% of comments

Of the characteristics of the interpersonal environment (i.e., university culture) that lead students to feel comfortable, student diversity was described as a positive by minority students (e.g., "I have friends in my classes, and other people who are like me in the socioeconomic and cultural group sense." [woman, biomedicine]). Positive student interactions and perceptions that other students are welcoming enhances inclusion for others (e.g., "I feel included attending my classes because most of my peers are supportive of my opinions and thoughts" [woman, undecided major]). Beyond the classroom, membership in clubs, societies and colleges increases engagement, which consequently improves perceptions of belonging (e.g., "The places I feel like I belong are uni clubs" [man, science]).

Individual level ~ 5% of comments

This final level captures characteristics of individual students that increase perceptions of belonging and inclusion. Students who are intrinsically motivated by their career or studies report a higher sense of belonging (e.g., "I feel as though everyone is excited and willing to learn, the same as me" [man, science]). Other students report being engaged and belonging in the environment, despite being introverted and requiring few social connections (e.g., "I appreciate the academic culture on campus as you are able to spend time with yourself and everyone else is too, and that to me is my feeling of belonging and accepting" [woman, biomedicine]).

Self-reported neurodivergent students

Finally, because neurodivergent students had lower perceptions of belonging and inclusion, we explored the barriers and facilitators reported for this group. Neurodivergent students made up 20% of the sample, hence a proportion of responses higher or lower than ~20% in each category would suggest over or under representation by neurodivergent students, respectively. Percentages in parentheses below indicate the proportion of a qualitative factor represented by neurodivergent students.

Compared to neurotypical students and those who did not respond to this question, neurodivergent students were much more likely (52%) to report interpersonal barriers with other students (e.g., "sometimes people feel fake" [woman, information technology]; "I sometimes feel that my opinion as a neurodivergent, disabled person is often ignored" [non-binary, science]). Neurodivergent students were also disproportionately more likely to mention poor class design (37%), self-doubt (30%), and the impersonal nature of the university (30%) as barriers to belonging. Conversely, neurodivergent students were less likely to report positive student interactions (10%) and being part of a smaller cohort did not appear to be a protective factor for these students (7%).

Discussion

This study aimed to investigate students' sense of belonging and inclusion in a large STEM degree program, using both quantitative measures and qualitative reflections. Overall, the results show that students in our sample reported a fairly strong sense of belonging and being actively engaged in their studies. This suggests that the general climate in the Bachelor of Science is positive for many students, and that initial post-pandemic efforts to create an inclusive environment may be yielding benefits. Although we did not specifically target these interventions in this survey (they are at various stages of maturity and most are being locally implemented at the subject level rather than coordinated at the degree level), some examples include; a compulsory first-semester first-year transition subject with small-class (18 student) tutorials, women-only and low-sensory tutorials in mathematics, efforts to replace PDF document formats with accessible learning materials, and Indigenising elements of the biological science curricula. However, there have also been some increases in class sizes and experimentation with flipped teaching models as academics have looked for new ways to engage students. It was expected that the analysis would uncover specific challenges and disparities that need to be addressed to ensure all students feel equally included. Understanding the nuanced experiences of the student cohort at this institution is seen as key to improving on and coordinating future efforts to improve student belonging in the BSc.

One notable finding was the lack of substantial differences in belonging scores between demographic groups. Counter to our hypothesis and previous research (e.g., Good et al., 2012; Rainey et al., 2018; Smith et al., 2013), we found no evidence that women in our sample had poorer perceptions of belonging compared to men. Similarly, our sample did not show evidence of poor belonging for students who identify as gender diverse, CALD, first generation, sexual minorities, disabled or students from low socioeconomic neighbourhoods. This could be interpreted optimistically: it may reflect progress in making the BSc program more inclusive such that female students and other historically underrepresented groups feel included in the community. However, it is also possible that the lack of differences is partly due to limitations in the sample. For instance, the number of First Nations students was extremely small (only 3 respondents), making it impossible to detect any pattern for this group[1]. Further, using a volunteer sample may have introduced self-selection biases, as those who already feel a strong sense of belonging may be more likely to participate, while those who feel excluded may opt out. But this does suggest that where our findings show students struggling, that the problem is likely of a greater magnitude than we have been able to detect.

Additionally, the high overall means and use of composite measures could mask subtle group differences: most students said they felt they belonged, leaving little variation to statistically explain. It's worth noting that some female students still reported instances of exclusion (e.g., being ignored by male peers in class), a theme which has been observed in other studies of gender equality (e.g., Fisher et al. 2020). This suggests that, even if on average women felt a

[1] In our sample of First Nations Australians, all three participants belonging scores fell within one standard deviation of the means for active and passive belonging. This suggests that these students report similar levels of belonging compared to the wider cohort. Given the small sample, we caution that this sample may not be representative of the wider Indigenous or First Nations Australians student population.

decent level of belonging, specific negative experiences related to gender do occur. Further, observation of the raw scores in Figure 1 reveals that although most students experience strong belonging and low incivility, there are students who do not fit this profile. These individual experiences, while not shifting the group mean, are important and suggest that continued attention to demographic characteristics in STEM classes is warranted.

The only demographic factor that did show a modest effect was neurodivergence, where neurodivergent students reported poorer passive belonging and were overrepresented among those voicing interpersonal difficulties in our qualitative analysis. This aligns with recent research pointing out that neurodivergent students often face unique barriers to inclusion in higher education (Gillespie-Lynch, Bublitz, Donachie, Wong, Brooks, & D'Onofrio, 2017; Syharat, Hain, Zaghi, Gabriel, & Berdanier, 2023). Social communication differences or sensory and cognitive processing needs might make traditional large-class settings particularly challenging for these students, leading them to feel less connected to other students (Salvatore, White, & Podowitz-Thomas, 2024). It is also possible that some neurodivergent students encounter stigma or lack of understanding from peers and staff, which can harm their sense of belonging (Griffin & Pollak, 2009; Syharat et al., 2023). The comments from the neurodiverse cohort in our study echo this, referencing feeling ignored or finding others fake. These findings suggest that additional support and inclusive practices are needed to better include neurodiverse learners. For example, educators could be more proactive in facilitating group interactions that are structured and supportive (reducing the social ambiguity that can be hard for some neurodivergent students), and universities could promote neurodiversity awareness to foster a more understanding peer environment.

It is important to note that a substantial proportion of participants (n = 105; approximately 33.7%) either did not respond to the question about neurodivergence or selected "prefer not to say". As this group reported relatively high mean active engagement, their unknown classification introduces uncertainty into the interpretation of group differences. It is possible that the observed patterns may shift if the true neurodivergence status of these students were known.

Significance and future directions

While our quantitative findings show relatively high belonging overall, students' qualitative feedback underscores the significance of structural and systemic features—such as class size, course design, and the perceived impersonality of the program—in shaping their sense of inclusion. Team or group tasks, which are designed to develop key skills as well as connect students to their peers, are complex in their interaction with belonging. Small-group learning has long-understood benefits for students in STEM (Springer, Stanne, & Donovan, 1999), but the potential pitfalls of group work may disproportionately disadvantage marginalised students (Fowler and Su, 2018; Theobald, Eddy, Grunspan, Wiggins, & Crowe, 2017). Scaffolding, clear communication and flexibility in expectations have been highlighted by neurodivergent students as supporting their inclusion when undertaking these tasks (Salvatore et al. 2024).

In our study, students reported that a lack of small-group learning in subjects with large cohorts and lecture-heavy delivery formats, made it difficult to form connections or engage

meaningfully with peers and instructors, factors also critical in shaping perceptions of learning (Wood & Tanner, 2012). Students also reported increased disruption to learning through noise and distraction, issues which have been previously identified for large classes (Cash, Letargo, Graether, & Jacobs, 2017). This tension between program scale and student experience suggests that creating a sense of belonging (and supporting learning) in large STEM programs requires intentional pedagogical and design interventions that prioritise interaction, discussion, and small-group connection within the broader course structure (Duncan, Holt, & Keenan, 2023). In response to this tension, Australian higher education institutions have been building large flat-floor teaching spaces that support hundreds of students to be taught simultaneously in active learning formats, replacing the opportunity for smaller class environments which may be more supportive of students' equitable participation (Ballen et al., 2019). There is minimal understanding of how these large active learning environments impact students' sense of belonging, particularly neurodivergent students, but results from our study and best-practice built environment guidelines such as Autism ASPECTSS suggest these may be problematic (Mostafa, 2021). Future research should investigate the effects of such interventions in diverse STEM cohorts.

Our findings also demonstrate the importance of qualitative data in understanding belonging. While mean scores suggested relatively equitable perceptions across demographic groups, open-ended responses provided more nuanced understanding of the student experiences, a phenomenon also noted by Fisher et al. (2020). This nuance offers helpful context for interpreting statistical trends and is essential for designing interventions that genuinely reflect students' needs. Hence, we argue that mixed-methods approaches should be included in future research, particularly when the experiences of underrepresented students are of interest. Longitudinal designs would also enable researchers to examine how students' sense of belonging and engagement evolve over time, rather than capturing only cross-sectional differences between cohorts.

Finally, this study provides a valuable baseline from which to monitor change over time. As this Australian university implements initiatives to improve inclusion, repeating this survey in future years could help track whether students' perceptions are shifting—and for whom. Caution should be taken when using the current data as a baseline due to the underrepresentation of cisgender men and gender diverse students, relative to the true 2024 cohort. Future research might also examine how individuals' sense of belonging changes across the student journey (e.g., from first to final year) or explore the effects of intersectionality, where multiple marginalised identities may lead to a cumulative effect on STEM inclusion. Building a culture of belonging is an ongoing process, and it must be informed by evidence, empathy, and student voice at every stage.

Conclusion

This study provides new insights into undergraduate science students' perceptions of belonging and inclusion in a large Australian STEM program. Using a mixed-methods approach, we found that while most students reported feeling a strong sense of belonging and active engagement, some groups—particularly neurodivergent students—faced unique barriers to inclusion. Our qualitative analysis highlighted the importance of class design, interpersonal dynamics, and personal circumstances in shaping students' sense of belonging,

revealing that inclusion is influenced by factors at multiple levels of the university experience.

Importantly, this research reinforces the value of gathering local data to inform targeted interventions. As universities seek to enhance belonging in STEM, efforts must be grounded in the realities of the specific institutional context. By embedding student voice in these efforts, institutions can create environments where all learners feel that they matter, belong, and can thrive in their STEM studies.

Conflict of interest

The authors declare that there is no conflict of interest.

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