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BELIEFS ON BELONGING: PERCEPTIONS OF FIRST YEAR ENGINEERING STUDENTS

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ABSTRACT

This study explores differences between perceptions of Traditional and Non-Traditional engineering students of their sense of belonging with a view to how this informs student intention to persist. This paper presents findings from an exploratory survey of (N=365) 1st year Bachelor of Engineering students at a Nordic Technical University. The survey was developed to explore background factors influencing student motivation and persistence. The results were analysed via R statistical software and reveal that nontraditional students, particularly those from diverse ethnic backgrounds, perceive a lower level of sense of belonging and academic support compared to traditional students. The results point to the need for universities to develop early-stage initiatives sensitive to the different challenges integrating academically and socially as is often experienced by non-traditional

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students. Thereby enhancing inclusivity and improving student persistence within engineering education.

1. INTRODUCTION

1.1 Background

In academic contexts, a sense of belonging is foundational for student success and well-being (Tinto, 2022; Strayhorn, 2018; Ulriksen, Madsen, & Holmegaard, 2015). A sense of belonging can enhance students' engagement in their studies, leading to increased effort, positively impacting achievement and increasing self-efficacy (Tinto, 2022). For students to perceive they belong is to perceive they are connected to and supported through their university experience by friends and colleagues, teaching staff and family (Strayhorn 2018; Tinto 2017a). Student connections to these groups and often to the university itself, contribute to their sense of identity (Ulriksen, Madsen, and Holmegaard 2010) and in turn their motivation (Tinto 2017a). Sense of belonging is often disrupted during transition to university, and so when necessary connections cannot be made, students may withdraw from activities, both social and academic, decreasing the likelihood of persistence (Tice et al., 2021; Rainey et al., 2018; Strayhorn, 2018; Tinto, 2017).

A sense of belonging for minority students can be especially important for persistence at university. This is emphasised further in STEM fields where altogether dropout is higher than other disciplines (Fan, Luchok, & Dozier, 2021) and minority students tend to dropout more than majority students, which is often influenced by non-inclusive learning environments (González-Pérez et al., 2022; Whitcomb & Singh, 2021; Hansen, Palakal, and White 2023).

Understanding and enhancing students' sense of belonging can therefore play a central role in promoting student persistence in higher education, as students who do not feel they belong are unlikely to persist (Tinto, 2017; Strayhorn,2018; Hansen, Palakal, and White 2023).

1.2 Literature Review

In many academic institutions the norms and values of university cultures are reflective of student groups that have traditionally been the majority, in terms of the characteristics they display. In many STEM academic settings, the majority of students have traditionally been white male students(Eastman, Miles, and Yerrick 2019; Park et al. 2020). This study uses the terms of "Traditional" and "Non-Traditional" students, introduced by Holmegaard, Madsen, and Ulriksen (2017), to explore the experiences and perceptions of those historically underrepresented in these fields, such as women and ethnically diverse students.

A student's journey into higher education, particularly within STEM degrees, is influenced by how well they can integrate socially and academically (Hansen, Palakal, and White 2023; Tinto 2022). As Ulriksen (2009) highlights, students who do not align with the traditional student archetype may find it challenging to be recognized and accepted as legitimate members of their academic community. This misalignment and resultant lack of recognition can set students apart. Those from non-traditional backgrounds may be especially affected, leading to a disengagement from their studies (Ulriksen, Holmegaard, and Madsen 2017; Strayhorn 2022;

González-Pérez et al. 2022). Therefore, the processes of integration and socialization will vary across different students in various STEM educations (Hansen, Palakal, and White 2023). These students engage in a continuous process of interpreting, balancing, and negotiating their educational experiences (Tinto, 2022). How students navigate this process is linked to their personal backgrounds and their cultural, ethnic, and socioeconomic origins (Tinto 2017; Ulriksen, Madsen, and Holmegaard 2017). Tinto (2022) and Strayhorn,(2018) emphasise the role of the university community in developing students' social integration and engagement. Teachers, support staff, and fellow students are key to fostering students' sense of belonging. This is particularly important in the first year of higher education, where the highest proportion of students leave (Tinto, 2017). However, it is not engagement per se, but the quality of the engagement which is important (Tinto, 2017). How the students interact and how they perceive their interactions, determines their sense of belonging (Gasiewski et al. 2012; Tinto, 2022). Conversely, the absence of belonging can erode students' commitment to the university and decrease their likelihood of persisting in their studies. This dynamic is particularly pronounced for non-traditional students in STEM fields, where the barriers to success are often greater (Holmegaard, Madsen, and Ulriksen 2017; Tinto 2022). A robust sense of belonging, therefore, becomes key for their academic advancement and persistence (Rainey et al., 2018; Strayhorn, 2018, 2022). While social belonging, fostered by shared interests and communal experiences within the university is key for the engagement of 'nontraditional' students', Tinto (2022) argues that it is academic belonging that exerts a more substantial influence on success. This form of belonging significantly boosts students' self-efficacy and enhances learning outcomes (Ibid). Supportive classroom environments and empathetic teachers underpin academic belonging through encouraging student motivation (Tormey, 2021; Hartikainen, Pylväs, and Nokelainen 2022). Consequently, this generates increased effort, leading to a more conducive environment for learning (Tormey 2021; Hartikainen, Pylväs, and Nokelainen 2022; Kirby and Thomas 2022; Holmegaard, Madsen, and Ulriksen 2017).

The objective of this study is to explore potential differences in the sense of belonging between traditional and non-traditional engineering students at a Nordic Technical University.

The research aims to identify specific areas where engineering institutions can enhance support and inclusivity measures which has resulted in the following research question:

Research Question: Are there differences in perceptions of belonging between traditional and non-traditional Bachelor of Engineering students?

2 METHODOLOGY

2.1 Study Design

In this exploratory study, we developed a survey targeting first-year engineering students at the end of their first semester in the Bachelor of Engineering degree. Data were collected from 365 first-year engineering students, representing 34% of the study population for that year. Among the participants, 67% identified as male, 32% as female, and 1% as non-binary or prefer not to say. Regarding ethnicity, 65%

identified as Nordic Traditional Ethnicity (NTE), 27% as Non-Traditional Ethnicity (NTE), and 8% as International (INT).

The survey included 11 items designed to measure various dimensions of sense of belonging, including academic support, social integration, and institutional support. These items were developed based on existing literature on student sense of belonging, motivation, and educational engagement. Responses were collected using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Additionally, the survey included demographic questions on ethnicity and gender.

Data were collected from 13 study lines across 12 Danish language engineering courses. Data collection commenced in January 2023 using an online survey tool (Surveyxact.dk) and was subsequently imported into R for analysis. The data collection period spanned the first and second weeks of a 3-week course period to avoid biases from study fatigue or exam stress.

In order to evaluate the internal consistency of the survey instrument, which has not been previously validated given its exploratory nature, a Cronbach's alpha analysis was performed. This analysis yielded a reliability coefficient of 0.83 (see Table 1), surpassing the acceptable threshold of 0.70 and thus affirming the interrelatedness of the survey items. However, it is important to note, following Grau (2007), that this score does not necessarily imply unidimentionality of the construct being measured.

To investigate differences in perceptions of belonging among students of different ethnicities and genders, we conducted a series of statistical tests on our survey data. The primary aim was to determine if there were significant differences in how various student groups perceive their academic and social belonging within the university.

Prior to analysis, data were cleaned to remove cases with missing values and to ensure the integrity of the dataset. Despite likert scales being ordinal and non-normally distributed, we refer to (Norman 2010; Mircioiu and Atkinson 2017) who state that parametric tests are appropriate for likert scale analysis.

We employed two main types of statistical tests to analyze the data: Welch's t-tests and Analysis of Variance as well as a Tukey's Honest Significant Difference (HSD) post-hoc tests to identify which specific groups differed from each other.

We used the Welch's t-test to compare the mean levels of agreement between male and female students for each variable related to the sense of belonging. We used this test instead of the standard t-test because it is preferred when dealing with unequal variances between groups robust against violations (Ruxton 2006; Delacre, Lakens, and Leys 2017).

2.2 Statistical Tests

To compare the mean levels of agreement across the three different ethnic groups simultaneously, we used ANOVA as advised by (Maxwell and Delaney 2004). When ANOVA indicated significant differences, we used Tukey's Honest Significant Difference (HSD) post-hoc tests to identify which specific groups differed from each other.

3 RESULTS AND DISCUSSION

3.1 Tables

Table 1. T-test Results by Gender (Percent Agreement and P-values)

Variables related to sense of belonging	% Agreement Males (N=244)	% Agreement Females (N=124)	P-value (significance p ≤ 0.05) of observed differences between groups
My teacher explains things well	54	40	**0.004****
My teacher encourages me to do well	45	37	0.326
The social relations with other students	63	66	0.421
I am well supported by my network	69	66	**0.750**
The university helps to provide a good social network	62	42	**0.0003*****
Good student-teacher interaction is important	84	82	0.458
I have a sense of belonging at university	55	51	0.261
My teachers respect me and act with empathy	49	41	0.246
The university values my opinions	46	33	0.027*
The university has an open-door policy and I am comfortable using it	50	42	**0.037***
The university creates an environment where I am included	63	54	**0.065**

* p < 0.05, ** p < 0.01, *** p < 0.001

Table 2: ANOVA and Tukey HSD Results by Ethnicity, the significant responses are highlighted in bold type.

Variables related to sense of belonging	Proportions of agreement for each statement according to ethnicity group			P Value (significance p ≤ 0.05) of observed differences between groups
In relation to my motivation to study I believe:	Nordic Traditional Ethnicity (NTE) (65%, n=238)	Non-Traditional Ethnicity (NE) (27% n=98)	International (INT.) (8% N=29)	
My teacher explains things well	0.57	0.31	0.62	**0.00*****
My teacher encourages me to do well	0.48	0.30	0.42	**0.03***

The social relations with other students are important	0.68	0.60	0.42	**0.04***
I am well supported by my network	0.76	0.56	0.42	**0.00*****
The university helps to provide a good social network (via activities and clubs)	0.62	0.42	0.50	**0.01***
I have a sense of belonging at university	0.58	0.44	0.50	**0.03***
The university creates an environment where I am included	0.64	0.51	0.65	**0.01***
Good student-teacher interaction is important	0.86	0.81	0.73	0.17
My teachers respect me and act with empathy	0.51	0.37	0.50	0.19
The university values my opinions	0.45	0.40	0.23	0.08
The university has an open-door policy and I am comfortable using it	0.50	0.45	0.38	0.49

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2 Perceptions of Belonging in Traditional and Non-Traditional Students

This study highlights the significant variation in students' perceptions of belonging and academic support across different ethnic backgrounds and, to a lesser extent, gender. Traditional students predominantly reported higher levels of agreement regarding positive interactions with faculty and a sense of being valued and supported within the academic environment. This comparison demonstrates a consistently higher level of agreement among traditional students for all statements relative to their non-traditional counterparts. The analysis, as detailed in Tables 1 and 2, utilizes Welch's T-Tests and ANOVA tests to examine the differences in perceptions related to sense of belonging and motivation to study across both gender and ethnicity. Statistical significance conveyed those results that can be considered representative of student perceptions.

Academic Belonging

Regarding the statement '*My teacher explains things well'*, both Traditional (NTE) and International student groups displayed similar levels of agreement, contrasting with the Non-Traditional Ethnicity (NE) students, who exhibited a significantly lower rate of agreement at 31%. A gender disparity was also noted, with a higher

percentage of males (54%) in agreement compared to females (40%), a difference that was statistically significant.

For the assertion '*My teacher encourages me to do well*', NE students again showed the lowest percentage of agreement compared to the other groups, with none surpassing 50% agreement. This was also statistically significant, and the finding suggests a universal perception of limited encouragement from teachers across ethnic groups. This aligns with the literature indicating that non-traditional students often struggle with recognition and acceptance in academic communities, which can lead to disengagement (Ulriksen, Holmegaard, and Madsen, 2017; Strayhorn, 2022; González-Pérez et al., 2022). Although this was not significant for the gender group, there were observed low levels of agreement, particularly among females, which may either underscore the challenges faced by women in feeling supported and encouraged within the academic setting or the lack of significance indicates that this is not an influential factor for motivation and belonging.

Although over 70% of respondents acknowledged the importance of student-teacher interaction for motivation, the actual agreement levels on good student-teacher interactions were not statistically significant. This highlights either a potential gap between the recognized importance of these interactions and the actual experiences of the students. Tinto (2022) and Strayhorn (2018), Tormey (2021) and Hartikainen et al. (2022) all agree teacher-student interaction can have yield a considerable influence on student sense of belonging. Alternatively, it could be interpreted as students are in agreement and uniformly experiencing these interactions, but the quality or depth of these interactions may not be meeting their expectations or needs.

Supportive classroom environments and empathetic teachers are an important part of developing academic belonging (Tinto, 2022; Tormey, 2021; Hartikainen, Pylväs, and Nokelainen, 2022). However, the notable decrease in agreement regarding the statement that teachers respect students and act with empathy, especially among non-traditional ethnic groups, signals that these supportive conditions are not universally experienced. Although this was not found to be statistically significant, this could be a case of students only 'knowing what they know' and may possibly reflect general norms in teaching as 51% or less agreed. Although students may not directly perceive this as an influence of motivation either at this stage or generally, it is nevertheless a factor that may impact student motivation over time, leading to lower self-efficacy and diminished learning outcomes for students in general but especially non-traditional students (Tinto, 2022; Holmegaard, Madsen, and Ulriksen, 2017).

Social Belonging

The assertion that '*The university has an open-door policy and I am comfortable using it*' received lower agreement rates from females compared to males, a difference that was statistically significant. This reveals gender disparities in perceived accessibility to support, aligning with findings from González-Pérez et al.(2022), that women in STEM often feel less included and supported.

Similarly, both International and NE students reported lower agreement levels than NTE students, albeit not significantly. This could suggest that non-traditional students may perceive institutional support structures as less accessible or welcoming, yet not to the extent that it influences motivation.

The statements regarding inclusivity of the university environment *'The university creates an environment where I am included'* highlighted lower agreement rates for NE students relative to NTE and International students, and lower for females than males – both differences reaching statistical significance. This supports the literature that non-traditional students often feel marginalized in academic settings that reflect the norms and values of the majority group (Ulriksen, 2009; Eastman, Miles, and Yerrick, 2019). Therefore, including students that are outside of the cultural norm, becomes a fundamental element when developing sense of belonging (Strayhorn, 2018; Tinto, 2022).

The perception that '*The university does well in providing a good social network*' showed reduced agreement among both female and NE students, compared to their male and NTE counterparts, respectively. This aligns with research indicating that social integration is a significant challenge for non-traditional students (Hansen, Palakal, and White, 2023; Tinto, 2022).

The significant finding that international students viewed social relations with other students as less important for their motivation further complicates the picture. It suggests that international students may prioritize other aspects of their university experience over social integration, potentially due to cultural differences or varying expectations of academic life – such as being temporary students (Tinto, 2022; Ulriksen, Madsen, and Holmegaard, 2017).

Conversely, the statement '*The university values my opinions*' received less than 50% agreement from all surveyed students but was not statistically significant. This suggests a broader issue where students across all demographics feel undervalued. This finding highlights the importance of creating a participatory and inclusive culture where all students feel their voices are heard and valued (Gasiewski et al., 2012; Tinto, 2022).

4 SUMMARY

The study's results show that indeed there are differences in the perceptions of sense of belonging variables between traditional and non-traditional students. Although there were differences between male and female perceptions, the differences were more pronounced between traditional students and non-traditional students based on ethnicity. This indicates that there are some underpinning cultural factors, perhaps related to communication styles, cultural norms, and the level of encouragement offered by teachers, that could be further studied in order to bridge the gap. There is a completely different make-up of the student population than has been traditionally. The new student population has a less positive perception of their experience at university in these initial months than traditional students, suggesting that the culture is still orientated to a previous type of student. As the first year is so important in order to mitigate dropout, paying attention to academic sense of belonging and in particular teacher encouragement and teacher explanations could be prudent. Studies show that more explicit communication is beneficial for non-traditional students, as they are less likely to be as fluent in the norms and values of university culture as traditional students. Furthermore, by creating a more 'humanised' approach enables students to develop more connections between each other, the teacher and the university.

Further studies should investigate effective initiatives to increase students' sense of belonging, considering how various student characteristics factor into this dynamic. For instance, it would be valuable to examine whether students who perform well academically tend to have a higher sense of belonging.

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