Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #47500

WIP: Comparing persistence in engineering education between direct entry and transfer students using a comprehensive survey tool

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1.0 Introduction

Engineers are empowered by society to apply their talents and knowledge to make the world a better place. Engineering schools and the engineering professional bodies have increasingly recognized that diversity in the student body enhances innovation and creativity, developing solutions that better address the complex, global challenges of the modern world. While recognized, and despite addressing the issue of diversity, equity, and inclusion through several initiatives, there are still challenges to overcome. For example, despite modest progress in Engineers Canada's 30 by 30 initiative, which aims to increase the proportion of female registrants to 30% by 2030, it is unlikely that this goal will be achieved. As of 2022, newly licensed female engineers make up 20.2% of total registrations, up from 17.2% in 2017 [1]. Further, Indigenous participation in engineering is 0.6%, despite having a 4.9% share of the total population in Canada [2].

Transfer pathways between colleges and teaching intensive universities (TIUs) and engineering schools at (typically) research-intensive universities (RIU) disproportionately improve access to, and persistence within, engineering degrees for visible minorities [3,4]. This impact may extend to other so-called "hidden" demographic student characteristics (e.g., social economic background, sexual orientation, and mental and physical health), but this impact is more difficult to evaluate as such data has not typically been collected by admission offices at post-secondary institutions [5]. Collecting data for both direct and transfer cohorts to understand non-visible demographics is needed to promote and engage with individuals who have been historically under-represented within the field.

In earlier work, we discuss the development of a survey instrument that aimed to explore student experience through a comprehensive, student-facing, and voluntary questionnaire [6]. This study was limited to engineering students at two post-secondary institutions, including one TIU and one RIU. Within the framework of self-determination theory (SDT), and through a set of defined and open-ended survey questions, coded as addressing autonomy, competency, or relatedness, the resulting survey sought details such as physical and mental health, home life, sexual orientation and gender identity, and belonging to better contextualise the student experience than what may typically be formally captured by institutions. Voluntary in-person interviews were also conducted to gain better feedback on how questions were received by student respondents, and suggestions for adjustments moving forward.

The current work-in-progress paper describes the introduction of this survey instrument to a broader group of transfer institutions and engineering schools within British Columbia (BC) with the aim to explore the self-reported demographic differences and similarities between transfer and direct entry students. Although mostly consistent with the first iteration of the survey instrument, slight changes were made for this work including:

- To allow for basketing of respondents with others from their institution, a series of sorting questions (e.g., *At what institution are you currently studying?*) were included at the start of the survey. Subsequent questions in the survey were generalized for all respondents regardless of their post-secondary institution of study.
- Several attention checks were included in the survey (e.g., *Please select 'Strongly agree' to show that you are paying attention to this question*).
- The option to skip closed-ended questions was removed (open-ended questions remained skippable). This change was intended to ensure that students who submitted the survey for tabulation at the end were engaged with the survey questions.

1.1 BC Transfer System

The post-secondary system in British Columbia consists of an integrated network of colleges, TIUs, and RIUs that supports student mobility through a formalized transfer system. The BC Council on Admissions and Transfer[1] is the agency tasked with facilitating admissions, articulation, and transfer arrangements among BC Transfer System member institutions, as well as conducting research to support student and credit mobility.

Most rural and urban colleges and TIUs in BC offer a defined set of first year courses that allow students in their regions to access engineering education [7]. Approximately 20% of engineering students in the province began their studies at these institutions prior to transferring to one of eight engineering schools[2] to complete their degrees. This consistency in first-year academic content experience across all post-secondary institutions provided an opportunity to study the diversity of student experience of those first entering engineering studies throughout the province.

1.2 Self Determination Theory

In the context of engineering, the psychological concept of Self-Determination Theory intends to design and understand how engineer students are motivated in their work, focusing on fulfilling their basic psychological needs for autonomy (feeling in control), competence (feeling capable), and relatedness (feeling connected to others) to foster intrinsic motivation and optimal performance within an engineering environment [8]. SDT posits that self-determination spans a continuum from amotivation, to extrinsic motivation, to intrinsic motivation. Satisfying the three psychological needs allows for an individual to be intrinsically motivated.

In our previous paper, we report how questions within the survey were coded within the SDT framework; the survey discussed in this paper makes no notable changes to the questions asked resulting in the same distribution: 39 autonomy, 25 competence, and 52 relatedness. Note that more than one code could apply to individual questions.

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[1]www.bccat.org

[2]University of British Columbia - Vancouver campus; University of British Columbia - Okanagan campus; Simon Fraser University - School of Engineering Science, School of Mechatronics Engineering, and School of Sustainable Energy Engineering; University of Victoria; University of Northern British Columbia, and Thompson Rivers University

In that earlier work, we noted that a meta-analysis of SDT studies suggested that competence is the strongest predictor of self-determination followed by autonomy and then relatedness [9]. At that time, we were tentative in our distribution of questions stating that the number of questions related to each psychological need should not suggest the importance of the psychological need. However, an earlier study by Trenshaw et al. [10] demonstrated that relatedness was the most important need for promoting intrinsic motivation for their course involving college students, drawing a distinction between research conducted with K-12 students versus post-secondary students. As they suggest, college students may not have the same networks for relationships as K-12 students. Although their study was local to one institution and just one class, it is a reminder that differences between K-12 students and post-secondary students may exist.

2.0 Methodology and Response Rate

First-year engineering students at several colleges and TIUs including Langara College (LANG with a potential respondent size, *n*, of 70 students), Douglas College (DOUG, *n* = 80), Kwantlen Polytechnic University (KPU, *n* = 62) and Vancouver Island University (VIU, *n* = 42), and the Schools of Engineering Science (ENSC, *n* = 262), Mechatronic Systems Engineering (MSE, n = 105) and Sustainable Energy Engineering (SEE, *n* = 41) were invited to participate in the study. For the purposes of this paper, ENSC, SEE, and MSE will collectively be referred to as receiving schools, or RX. LANG, KPU, DOUG, and VIU will collectively be referred to as transfer institutions, or TX.

The invitation to participate in the first-year cohort at each institution was through a brief, in-person classroom presentation outlining the purpose of the study followed up with a link to the survey (hosted on SurveyMonkey). The 86-question survey was open to students for a one-month period towards the end of the semester (04-Nov-2024 to 04-Dec-2024). The timing of the survey allowed for questions related to experiences that happen in the first few months during the transition to university.

Figure 1 shows three response rate plots: the amalgamation of all institutions, of all TX only, and of all RX only. Students are not able to skip close-ended questions; as such, the number of respondents to a given question measures the points in the survey when students are no longer engaged. To aid in visual clarity, branched questions and open-ended questions are removed from this analysis.

The largest drop-off of participation occurred when students were asked about their identity. This observed drop-off was consistent between both the TX and RX respondents; it also aligns with what was observed in earlier work [6]**.** The identity questions consisted of two open-ended questions: *What aspects of your identity are significant to you?* and *In what ways does your identity shape your experience at [post-secondary institution]?* These questions were not required to continue the survey. The overall response rate for these questions was 34 and 35, respectively.

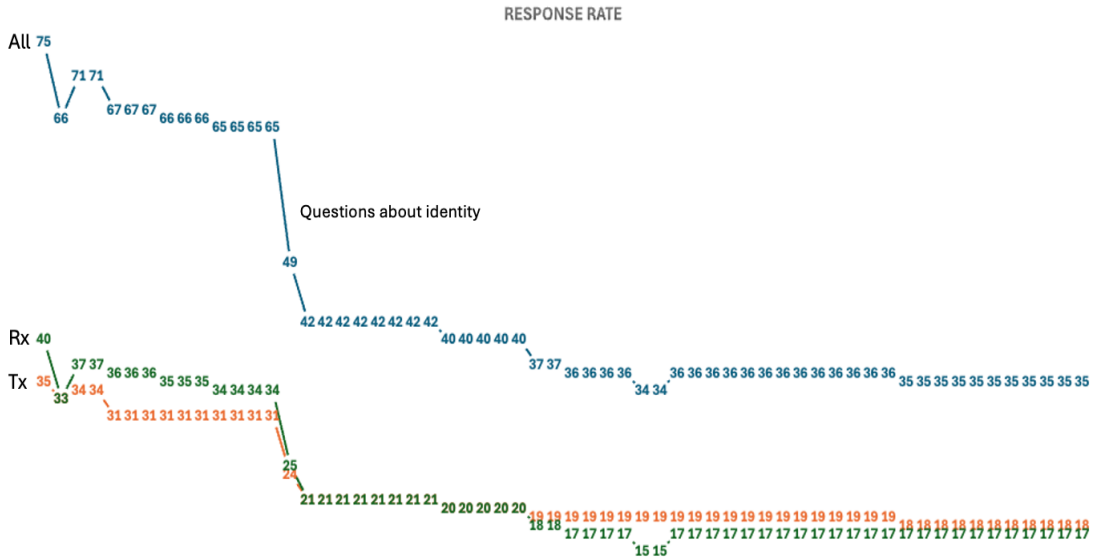


Fig 1: Overall response rate for questions from first-year students

The next question, which was closed-ended, asked students on a five-point Likert-type scale to respond to the statement *It is important that your identity is represented and included by the [post-secondary institution] engineering environment/community.* An open-ended question followed that asked students to elaborate on their answer. Capturing aspects of student identity are important as it relates to the SDT concept of relatedness, as discussed earlier. It is not yet clear why this drop-off is consistently observed (e.g., location of question in survey, open-ended vs close-end style), but this behaviour is being considered when developing future iterations of the survey instrument.

Figure 2 shows the time to completion visualized as box plots for those who completed the survey (*Yes*) and for those who left before completing (*Skip*).

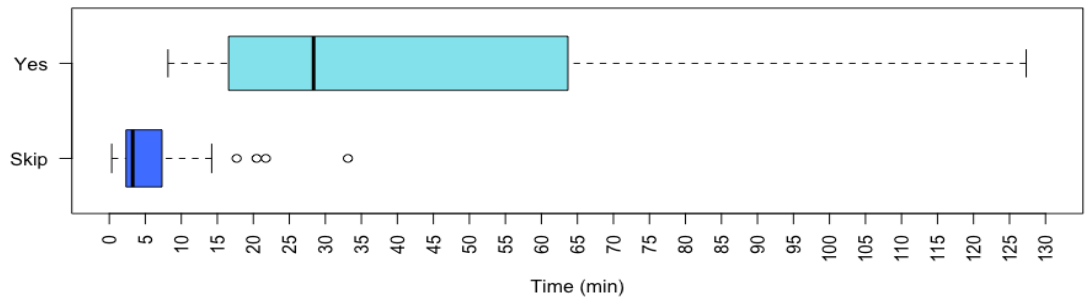


Fig 2: Boxplots for Time to Completion

The median time to completion for those who finished the survey was approximately 28 min, whereas the median time in the survey for those who did not finish was 3.3 min. Extreme outliers have been removed from the figure: for *Skip*, an outlier of 2097.8 min is not shown and for *Yes* six outliers are not shown: 229.8 min, 491.2 min, 542.2 min, 2684.9 min, 4088.8 min, and 7183.5 min. For the *Yes* group, these very long completion times most likely represent students who kept the survey open but were not actively working on it.

3.0 Results and Discussion

3.1 Survey Demographics

Post-secondary institutions currently collect limited demographic data from incoming students, typically limited to (binary) gender and international status. Race, ethnicity, and ancestry data may be collected, but the collection and use of this data is often inconsistent between institutions making system-level evaluation difficult [5].

For this survey, Table 1 summarizes the students who participated in terms of the number of students in the first-year cohort who were provided access to the survey, the response rate for each institution, and the proportion representation of international students and female students within that first-year cohort. For SFU, the representation of international students was provided at the program-level; other institutions provided data at the course-level.

Table 1. PSI-Sourced Student Demographics and Survey Response Rate

Institution/School	1st-Year Cohort Size	Response Rate	Int'l Students (%)	Female (%)
ENSC (SFU)	262	6.4%	15% (program-level)	21%
SEE (SFU)	41	4.9%	11% (program-level)	35%
MSE (SFU)	105	1.9%	21% (program-level)	11%
LANG	70	11.0%	7.1% (course-level)	20%
KPU	62	1.6%	3.2% (course-level)	10%
DOUG	80	8.8%	13% (course-level)	~15%
VIU	42	4.7%	2.3% (course-level)	24%

3.2 Survey Demographic Comparison

The survey instrument was provided to students on a voluntary and anonymous basis; no explicit incentive was given. The response rate for the amalgamation of TX and RX institutions was 8.3% and 5.1%, respectively. Of these respondents, approximately 17% reported as female, while 8.6% chose not to answer. This result is generally consistent with the absolute (binary) gender split in the cohort provided by each institution, but whether the respondent demographic is generally consistent with the cohort cannot yet be validated.

The survey responses reveals a story for each student cohort: TX students were generally older than RX students (average of 21 vs 19), less likely to have directly started their studies after high school (44% vs 76%), more likely work to support their studies (28% vs 6%), have less of a commuting time (50% commute less than 30 mins; 40% of RX students commute more than 1 hr), and have a higher proportion of first-generation learners (15% vs 0%). Table 2 provides additional, self-reported demographic characteristics of the respondents.

Table 2. Select Demographic Characteristics

Identity	Tx	Rx
LGBTQ+	6%	12%
Black, Indigenous, or Person of Color (BIPOC)	50%	53%
Born in Canada (BiC)	62%	71%
English is the primary spoken language at home	71%	89%

The results shown in Table 2 are the amalgamated responses across all TX and RX institutions respectively. However, upon further examination, differences between specific institutional cohorts were apparent. For example, only 38% of students from Langara College reported as being born in Canada with 63% of its respondents identifying as "East Asian" (Japanese, Chinese, or Korean). In contrast, 86% of Douglas College respondents identified as BiC, with 57% identifying as "White" with no other identify holding most remaining students. These results reveal a challenge in considering amalgamated TX data: the demographic expression of the student cohort often differs between colleges and TIUs.

3.3 Persistence and Motivation

Considering questions related to the choice of respondents to both enrol and persist with engineering studies, TX and RX were similar in their responses to some motivating or impacting factors: *Securing a high paying job was an important factor for enrolling in engineering* (83% RX and 82% of TX respondents agreed or strongly agreed (A/SA)), while considerable differences to others: *Giving back to society and making a difference was an important factor for enrolling in engineering* (A/SA: 71% RX, 39% TX) and *Did you complete any courses related to engineering or a similar subject before coming to university?* (47% of RX students responded *Yes*, while only 10% of TX students reported the same). Select additional responses are shown in Table 3 and included:

Table 3. % Respondents who Agree or Strongly Agree with the Motivating Statement

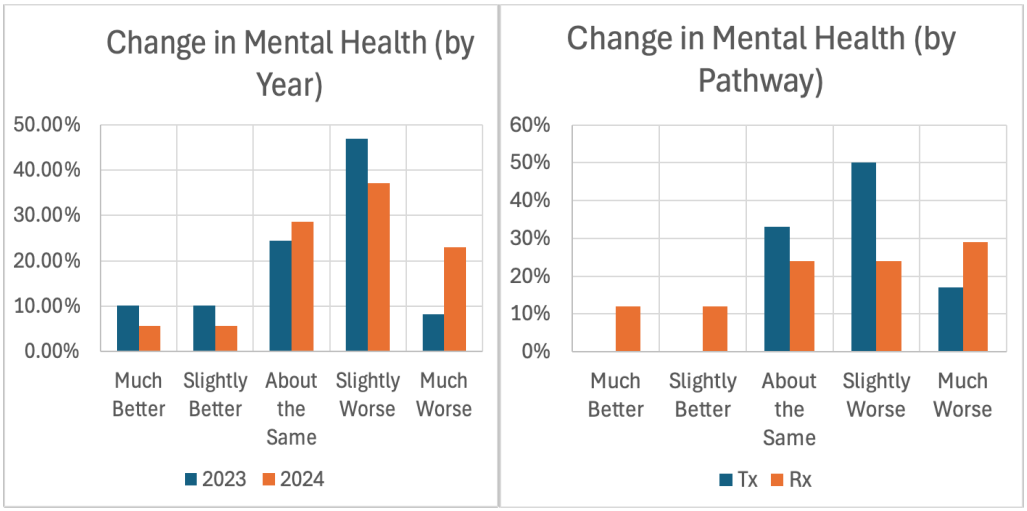
Motivating or Impacting Factor	TX	RX
The prestige and recognition associated with engineering was an important factor in my enrolling in engineering.	56%	76%
Selecting engineering was influenced by my parents or close relatives.	33%	24%
Selecting engineering was influenced by my high school teacher(s) and/or school counsellor.	11%	29%
The friendships I have made during my studies within engineering at [post-secondary institution] have been important factors for my continuing in engineering.	67%	53%
The professional relationships (including with your instructors, if applicable) I have made during my studies within engineering at [post-secondary institution] have been important factors for my continuing in engineering.	56%	29%

3.4 Comparison with Previous Survey Results

Although our earlier work was intended as a pilot to better hone the instrument, data was collected and analysed as part of that project [6]. As most questions provided in this second iteration of the survey were the same, the responses from each group can be compared for consistency.

For example, both iterations included the question: *In general, would you say your mental health (such as feeling anxious, depressed, or irritable) is very good, good, poor, very poor, or prefer not to answer.*

The results of two iterations are shown in Figure 3a**,** while comparing the responses of direct and transfer students in the most recent iteration are shown in Figure 3b. Here, respondents in the second iteration generally indicated a slightly worse evaluation of their mental health shift towards respondents indicating a slightly worse evaluation of their mental health, with TX respondents having worse evaluation of their mental health than RX respondents.

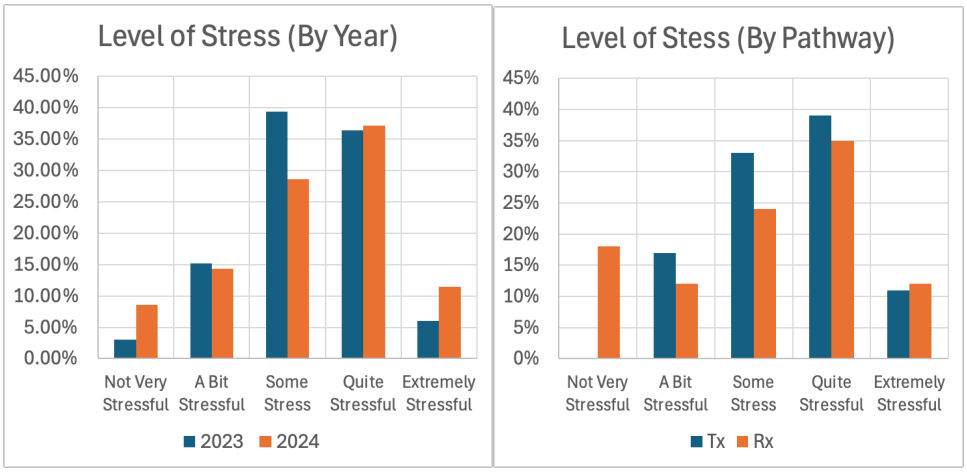


(a) **(b)**

Figure 3. Change in Mental Health for (a) All respondents by year, and the (b) TX or RX cohort

A similar analysis was undertaken on evaluating student stress. Here, the following question was posted to respondents: *Thinking about the stress in your life, would you say that most days since you started your studies at [post-secondary institution] are?*

The results of two iterations are shown in Figure 4a, while comparing the responses of direct and transfer students in the most recent iteration are shown in Figure 4b. Here, respondents in both 2023 and 2024 reported similar levels of stress; RX reported less stress than TX students, with 18% of RX respondents indicating no stress at all.



(a) **(b)**

Figure 4. Change in Stress Level for (a) All respondents and (b) Tx and Rx respondents

4.0 Conclusions and Future Work

This work-in-progress paper presented the preliminary outcomes from a survey instrument introduced to a select group of transfer institutions and engineering schools within British Columbia to better understand the first-year engineering student experience. Consistent with earlier findings, respondents were found to disengage from the survey when questions of identity are raised. Further results suggested specific differences within the transfer student and direct-entry student demographic (e.g., age, ethnicity and origin) and their motivation to study engineering and persistence to continue that study.

Although some demographic details of the survey respondents align with known data, such as gender, the overall response rate to the survey may impact how indicative the results are to the broader first-year cohort. To improve engagement, several changes are envisioned, including adding additional questions related to international status and incoming grades. Reordering questions, noting the impact on response rate, and inclusion of an incentive for completion (e.g., entry into a prize draw, or token payment) continues to be considered, and follows earlier work.

Moving forward, considerable analysis is still required: Better understanding how demographic groupings within the TX and RX cohort respond to specific questions coded for autonomy, competence, and relatedness will help to better address barriers that students may experience to persist in their engineering education. For example, as shown in Table 3, TX and RX had differences in their agreement statements, which may provide insights into the institutions they decided to enrol in. Additionally, the differences in the importance in friendships and professional relationships may provide details into how transfer students acclimate into RX. In SDT terms, further research should be conducted into how relatedness is affected when these students transfer to a new institution.

5.0 Acknowledgment

The authors would like to thank the course instructors at participating post-secondary institutions for providing access to their first-year engineering classes, as well as all students

who participate in this study. We believe your input will help mitigate barriers impeding equitable access to, and success within, engineering education for all students. Funding support has been provided through Vancouver Island University's Inquiry and Time-Release grants.

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