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Exploring Student Data Analytics: Four Initiatives in Engineering Education Research and Practice

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The Context

Postsecondary institutions collect information from their students via registration, the learning management system, and student surveys. These secondary data provide rich information about student experiences and outcomes.

The Problem

Data governance and the capacity for data analysis can limit the use of these data for institutional improvement and research purposes.

The Purpose

This poster showcases some enablers of student data analytics and the insights thereby obtained from four projects within the Faculty of Applied Science and Engineering, University of Toronto. These enablers and insights can help enhance institutional practice and scholarship on postsecondary student experiences.

Student Data Analytics

involves analysis of existing institutional data collected from students in a postsecondary institution. It can include two pairs of data analytics:

- Academic / institutional analytics, and learning analytics;
- Descriptive analytics, and predictive analytics

Project #1. NSSE-based data linking and analysis

Team leaders: Prof. Greg Evans and Dr. Qin Liu

Data Sources: 2017 and 2020 National Survey of Student Engagement (NSSE) data linked to Co-curricular Record, retention and graduation, and academic performance data.

Samples: 341 first-year students and 310 senior students (2017 data); and 371 first-year students and 231 senior students (2020 data)

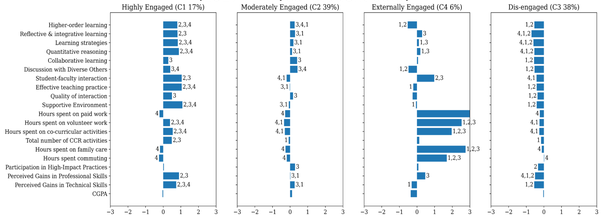
Data Elements:

- 10 Engagement indicators
- Time spent on co-curricular activities, work, family care, and commuting
- Participation in high-impact practice
- Learning outcome indicators: perceived gains, CGPAs, 2nd-year retention, and graduation

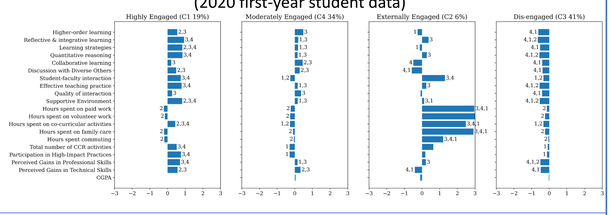
Research Question: What personas can be identified from student data that measure students' curricular and co-/extra-curricular experiences?

Four personas identified from k-means cluster analysis:
Highly Engaged; Moderately Engaged; Externally Engaged; Disengaged

(2017 first-year student data)



(2020 first-year student data)



Insights Obtained:

- Students can be clustered by their different levels of engagement with academic work, co-curricular activities, and activities outside school.
- These personas serve as a better predictor for subjective learning outcomes, such as perceived gains in competency development, than for objective learning outcomes, such as GPAs.

Opportunities for student data analytics: Linking survey and administrative data offers opportunities to probe the relationships between student experiences and subjective versus objective learning outcomes.

Acknowledgement: The graphs were created by Yulin Wang, Master of Science student in Computer Science.

Project #2. Multi-year survey data analysis

Team leaders: Prof. Greg Evans and Dr. Qin Liu

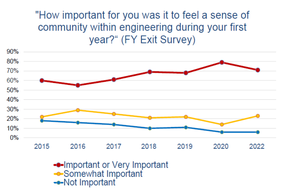
Data Sources:

- Seven years of Engineering Welcome Survey data (2016 to 2023, samples ranging from 510 to 1048 students)
- Nine years of First-Year Exit Survey data (2013 to 2023, except 2021, samples ranging from 154 to 363 students)
- Four years of Graduating Student Survey data (2017 to 2021, except 2020, samples ranging from 165 to 251 students)

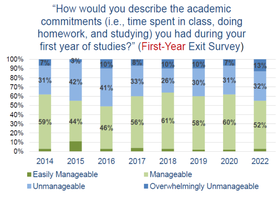
Topics in Survey Questions:

- Student support and services
- Academic pathways
- Competency development
- Highlights and challenges in student experience
- Student demographics and background

Highlights in Student Experience – First-year students



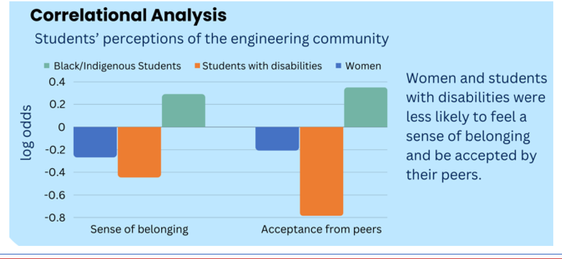
Challenges in Student Experiences: Academic Workload



Insights Obtained:

- A sense of community is increasingly important to first-year engineering students over the years.
- Managing academic workload is a persistent challenge for engineering students.

Engineering Welcome Survey data in 2018, 2019 and 2021 combined



Opportunities for student data analytics: Multi-year survey data can reveal persistent patterns in student experiences and outcomes, and allow probing into matters specific to some minority students.

Acknowledgement: The third graph was created by George Li, a Computer Engineering student, who was supported by the Data Sciences Institute in 2023.

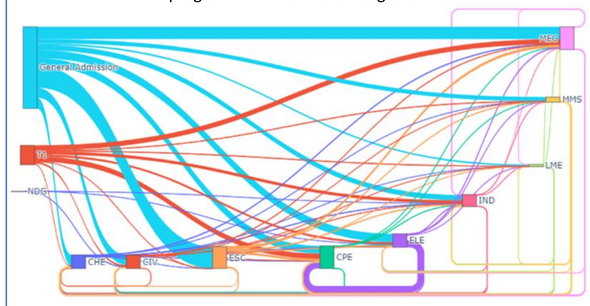
Project #3. 11-year enrolment and academic data analysis

Team leaders: Profs. Ariel Chan and Graeme Norval

Data Sources:
Enrolment and academic records of 11,227 engineering students who graduated between 2012 and 2022.

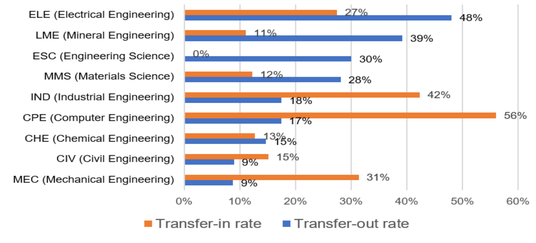
Data elements include course / program enrolment, co-op completion, minor and certificate completion, cumulative GPAs, and grades of math courses.

Sankey diagram illustrating the flows of engineering students between engineering programs from admission to graduation



(Source: Chan et al., 2023)

Transfer rates between engineering programs (except TrackOne) from admission to graduation



Insights Obtained:
About 1/5 of engineering students (excluding TrackOne, undeclared students) transfer to another program from the first year to the final year. Program transfer is part of their academic pathways during the engineering studies.

Opportunities for student data analytics: Enrolment and academic records can illustrate student pathways within the Faculty, and the relationships between course / program enrolment patterns and learning outcomes.

Acknowledgement: The Sankey diagram was created by Oluwadamilola Bolarin. Chan et al. (2023). Student data analytics in engineering education: Lessons learned from a Canadian engineering school. CEEA Proceedings.

Project #4. Analysis of application and admission data for graduate engineering programs

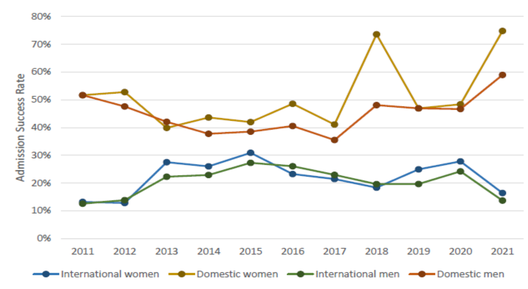
Team leaders:
Profs. Aimy Bazylak and Jason Bazylak, & Dr. Najme Kishani Farahani

Data Sources:

- Undergraduate students' registration and academic performance (2006-2021)
- Graduate students' application, admission, and registration data (2011-2021)
- Degrees awarded to graduate and undergraduate students (2011-2021)

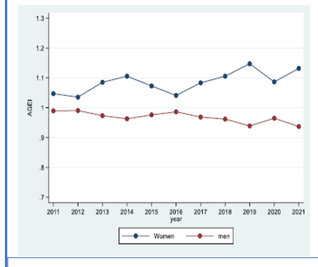
Purpose: To investigate the transition between undergraduate and graduate programs in engineering, and the graduate admission processes.

Acceptance rate across the Faculty, by gender and residential status

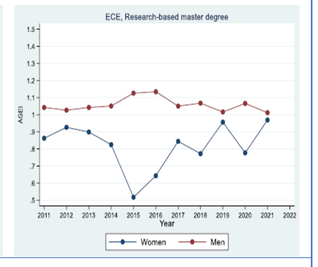


Admission Gender-Equity Index
(a ratio of the proportion of one gender identity group who were admitted, and the proportion of the same identify group who had applied)

Across the engineering Faculty



One program as an exception



Insights Obtained: Inequality exists in the admission outcomes for graduate-level engineering programs. The gap appears to be larger between international and domestic students than between women and men.

Opportunities to student data analytics: Disaggregation analysis of application, admission, and registration data can provide insights about potential inequality and inequity issues in the student admission outcomes.

Reference: Kishani Farahani, N., & Bazylak, A., & Bazylak, J. (2023). Unearthing gender equity: A data-driven analysis of application and admission patterns in graduate engineering studies. ASEE Proceedings.