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Analysis of the Impact of University Academic Requirements on Engineering Students' Outcomes

Dr. Rania Al-Hammoud, University of Waterloo

Rania Al-Hammoud is a lecturer and the current associate chair of undergraduate studies at the civil & environmental engineering department at university of waterloo. Dr. Al-Hammoud has a civil engineering background with research focusing on materials and the rehabilitation of reinforced concrete structures. She also has passion for engineering education and has published widely in this area. She cares about the success and well-being of her students, thus always being creative with the teaching methods in the classroom. Outside the classroom, she is an active person, with the following hobbies: hiking, biking and dancing.

Dr. Ona Egbue, University of South Carolina Upstate

Ona Egbue is an Associate Professor in the Department of Informatics and Engineering Systems at the University of South Carolina Upstate. She received her PhD from Missouri University of Science and Technology. Her research interests include socio-technical system analysis, critical infrastructure resilience, modeling of energy systems, decision making for complex systems, and engineering education.

Siwakorn Wisawakornwisit, University of Waterloo
Tesse Klompstra
Aotian Guan, University of Waterloo

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Abstract

The variation of progression rules in Canadian accredited undergraduate engineering programs reveals their impact on student outcomes, emphasizing the necessity for continuous review and adjustment to meet evolving education and professional needs. The information of first-year requirements, promotion rules, university ranking, and student retention was collected for 25 universities. The data was analyzed to compare academic requirements across institutions and assess their impact on student outcomes. The finding reveals variations in first-year requirements and promotion rules, demonstrating universities' autonomy in setting academic standards. While there is no noticeable correlation between academic requirements and university reputation, it highlights the important aspect of addressing student retention and mental health through initiatives to improve the sense of belonging and increased support services. Overall, the contrasting relationship between academic requirements, university ranking, and student satisfaction indicates the need for a thorough comprehension of the factors impacting student well-being.

Introduction

Universities have different systems and rules for students' progression in engineering programs. These rules are essential to ensure that students acquire the necessary skills to succeed in the engineering field. This study evaluates how these progression rules in accredited undergraduate engineering programs in Canada impact students' outcomes such as retention, perseverance, equity, and success. Progression requirements, which specify the process by which a student advances in their program of study, can vary drastically across engineering programs. Typically, academic standing, the status of a student's progress towards meeting program requirements, is determined at the end of every semester or term. In some engineering programs, progression to the next course or level is based on performance in individual courses whereas in other programs, such as some cohort programs, the decision on whether a student progresses to the next semester or term considers their performance in all courses completed in the immediately preceding semester. Similarly, in some programs, a student may choose to withdraw from one or more courses during a semester, sometimes right until the end of the semester. In contrast, other universities may place limitations on students' ability to withdraw from a single course during the semester. Depending on the situation, a student may not be permitted to withdraw from a single course and may face the choice to either remain in all their courses or withdraw from all.

These differences in academic requirements have various impacts on students' outcomes and have implications for success, diversity, and more. Therefore, it is necessary for universities to continuously review and adjust their academic requirements to meet the evolving needs of the engineering profession and a diverse student body. This study analyzes such requirements in 25 universities offering engineering programs in Canada and compares current practices with best practices identified in the literature. Furthermore, this paper provides insights on how varying academic requirements impact student outcomes and identifies gaps in current practices.

Study Approach

In this study, publicly available data on first year requirement, promotion rules, student retention, and university ranking was collected on each university. The information collected is described below.

First Year Requirements

The first step in the comparative analysis of undergraduate engineering in accredited Canadian universities involved gathering publicly available information on first year requirements. This information was primarily obtained from the university's websites. The language used to describe first year requirements varied across the universities. For example, McMaster University used the term 'Engineering I' to mean that all engineering undergraduate students take the same common courses in the first year which was categorized as a general first year (McMaster, n.d.).

Promotion Rules

Promotion rules were gathered for all Canadian universities that had accredited engineering programs. For each university, the following information was documented: the passing percent for each term, probation or conditional passing, and withdrawal requirements.

University Ranking

In this study, information on university ranking was obtained from Times Higher Education, U.S. News & World Report, and Quacquarelli Symonds (QS) World University Rankings. These three selected sources show the most recent data using a variety of factors such as faculty resources, student outcomes, research output, and so on (Krambs, 2024). It is important to note that these university rankings are based on a wide range of factors including factors unrelated to academic requirements. Therefore, the university ranking information in this study is used only to illustrate how undergraduate engineering programs in universities with a wide range of rankings manage progression rules.

Student Retention

Information on student retention was obtained from Maclean's Education (Maclean's, 2023). This website contained retention information on all but two of the universities; British Columbia Institute of Technology and Royal Military College of Canada. A search on the websites of the two universities not included in Maclean's Education did not reveal useful information on retention.

Results and Discussion

First Year Requirements

Nineteen universities and 6 universities have general first year requirements and non-general first year requirements, respectively, for engineering programs (see Table 1) It is evident from the results that institutions have different approaches first year requirements. Universities that offer general first year engineering courses offer a broad curriculum to all incoming students. In contrast, universities that offer non-general first year courses offer a set of courses specific to each engineering major.

Table 1: General first year and non-general first year universities

General First Year	Non- General First Year
Carleton University	British Columbia Institute of Technology
Concordia University	Lakehead University
Dalhousie University	McGill University
McMaster University	University of Northern British Columbia
Memorial University of Newfoundland	University of Ottawa
Queen's University	University of Waterloo
Royal Military College of Canada	
The University of British Columbia including Okanagan campus	
The University of Western Ontario	
Toronto Metropolitan University	
University of Alberta	
University of Calgary	
University of Manitoba	
University of New Brunswick	
University of Saskatchewan	
University of Toronto	
University of Victoria	
University of Windsor	
York University	

Promotion Rules

The promotion rules across various universities as outlined in table 2 demonstrate different sets of academic standards for students. The most common rule for eligibility to progress is the 60% term cumulative grade. McGill University, University of Alberta, and University of Ottawa require 55% term cumulative grade to pass, while Concordia University and some others require more than 60% term cumulative grade to pass. Royal Military College of Canada has a minimum passing grade of 50%. Overall, it highlights the autonomy of each university to its academic standards, offering a unique educational expectation.

Table 2: Promotion rules for accredited University

University Name	Passing grade
British Columbia Institute of Technology	*
Carleton University	63%
Concordia University	67%
Dalhousie University	60%
Lakehead University	60%
McGill University	55%
McMaster University	60%
Memorial University of Newfoundland	65%
Queen's University	60%
Royal Military College of Canada	50%
The University of British Columbia including Okanagan campus	(First Year - 60%, Second Year and on - 55%)
The University of Western Ontario	60%
Toronto Metropolitan University	60%
University of Alberta	55%
University of Calgary	64%
University of Manitoba	60%
University of New Brunswick	63%
University of Northern British Columbia	63%
University of Ottawa	55%
University of Saskatchewan	60%
University of Toronto	60%
University of Victoria	60%
University of Waterloo	60%
University of Windsor	60%
York University	60%

University Ranking

Table 3 shows the university rankings. The Times Higher Education (THE) ranking for "Best universities in Canada for engineering degrees 2024" is based on the overall score of research

quality, industry, international outlook, research environment, and teaching (Times Higher Education, n.d.). THE covers three areas of university including research, impact, and teaching (Times Higher Education, 2023). In the U.S. News & World Report, the methodology for ranking engineering involves academic research performance, bibliometric indicators including citations and publications from 2016 to 2020, and reputation in the subject (US News, n.d.). This methodology emphasizes academic research output and the impact within the field of engineering (Morse & Wellington, 2022). The QS World University Rankings for Engineering and Technology provides a comprehensive evaluation of universities such as academic reputation, employer reputation, citations per faculty, employment outcomes and so on (QS Top Universities, n.d.). The criteria include research citations, surveys feedback from academics and employers, and research impact (Lane, 2024).

These three sources provide various methodologies of ranking the university for engineering including research performance and impact, teaching environment, surveys feedback, et cetera. Given that the criteria used for ranking varies across the three sources used, universities may be ranked differently by each of the sources. Furthermore, multiple universities can receive the same ranking (i.e. they are tied). N/A was used to indicate that universities such as British Columbia Institute of Technology, Royal Military College of Canada, and University of Northern British Columbia had no available data from one or more of the three sources. Table 3, shows that based on the average of the three rankings University of Toronto was ranked at the top of chart and Lakehead University has the lowest ranking.

Table 3: University Rankings

Universities	Times Higher Education	U.S. News & World Report	Quacquarelli Symonds (QS) World University Rankings	Average
British Columbia Institute of Technology	N/A	N/A	N/A	N/A
Carleton University	8	9	13	11
Concordia University	7	6	11	8
Dalhousie University	9	14	14	15
Lakehead University	10	22	N/A	22
McGill University	4	5	4	4
McMaster University	6	8	8	7
Memorial University of Newfoundland	7	18	N/A	17
Queen's University	9	17	7	12
Royal Military College of Canada	N/A	N/A	N/A	N/A
The University of British Columbia including Okanagan campus	2	3	2	2
The University of Western Ontario	6	10	10	9
Toronto Metropolitan University	10	19	15	20
University of Alberta	5	4	5	5
University of Calgary	6	7	6	6
University of Manitoba	10	15	12	14

University of New Brunswick	7	20	N/A	19
University of Northern British Columbia	N/A	N/A	N/A	N/A
University of Ottawa	7	12	9	10
University of Saskatchewan	7	16	14	16
University of Toronto	1	2	1	1
University of Victoria	8	11	14	13
University of Waterloo	3	1	3	3
University of Windsor	9	21	N/A	21
York University	10	13	15	18

Universities Student Retention

Maclean's Education (Maclean's, 2023) records and compiles "... the percentage of full-time, first-year students enrolled in the fall of 2022 who returned to the university the following year". Table 4 below shows the students retention data including research student retention for all the universities except British Columbia Institute of Technology and Royal Military College of Canada. Information about these two universities is not available. The retention rate ranges from 93.9% at the University of Calgary to 74.8% at the Memorial University of Newfoundland. The average retention rate being 87.38%.

Table 4: *First-year student retention (%)

University	Student retention (%) (Maclean's, 2023)
British Columbia Institute of Technology	No information provided
Carleton University	90.1
Concordia University	86.3
Dalhousie University	85.5
Lakehead University	81.6
McGill University	93
McMaster University	91.5
Memorial University of Newfoundland	74.8
Queen's University	93.2
Royal Military College of Canada	No information provided
The University of British Columbia including Okanagan campus	91.9
The University of Western Ontario	92
Toronto Metropolitan University	88.3
University of Alberta	92.5
University of Calgary	93.9
University of Manitoba	85.9
University of New Brunswick	82.6
University of Northern British Columbia	79.5
University of Ottawa	85.6
University of Saskatchewan	84
University of Toronto	91.4
University of Victoria	85.1
University of Waterloo	92.5

| University of Windsor | 83.3 |
| York University | 85.2 |

*Retention rates of students (%) from first year to second.

There is a relationship between a student's sense of belonging and student's consideration of leaving university without finishing their degree. (Best Practices, 2017) The sense of belonging in this research is considered "a fundamental psychological need" and "... is essential in establishing and sustaining strong relationships with others (Maunder 2018), maintaining academic motivation and contributing to success in higher education". The results showed that students who indicated that they sometimes considering leaving university had a lower sense of belonging than the student who never considered leaving or considered leaving only once or twice. Furthermore, students who indicated that they often considered leaving university had an even lower sense of belonging. The graph below shows the mean sense of belonging compared to the number of times students considered leaving the university. The error bars represent 95% confidence intervals.
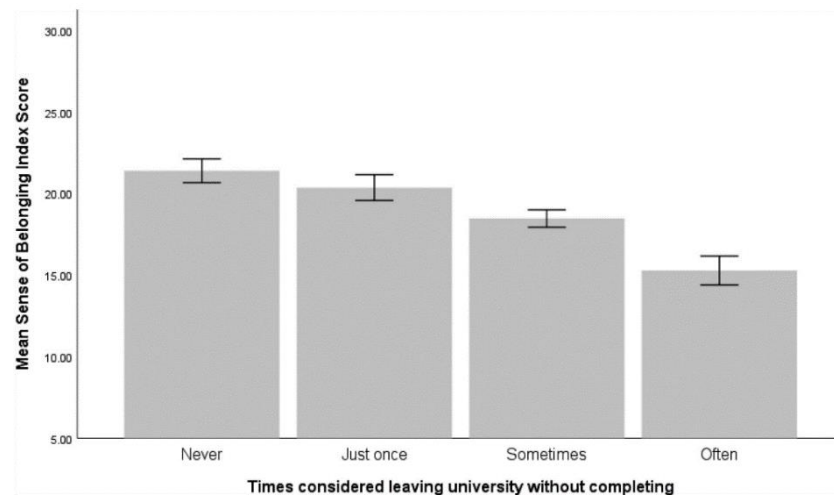
Sense of belonging vs. Time considered leaving university without completing. Graph from *Journal of Further and Higher Education* (Pedler et al., 2022).

Many of the universities in this study have programs to improve students' sense of belonging. For instance, Carlton University developed a program called From Intention to Action (FITA) (Meissner et al., 2014-17) to help with student retention and the students mental health. This program focuses on students struggling with leaving home and the stress surrounding competing for grades and a career. FITA is a twelve-week program that provides students with guidance "to develop an understanding of the strengths, challenges, and issues that…influence their abilities to succeed". Carlton University increased student retention and now has an above-average percentage.

Table 6 Student Mental Health

Universities	Medical/Doctoral	Comprehensive	Primarily
British Columbia Institute of Technology	N/A		
Carleton University		3	
Concordia University		4	
Dalhousie University	6		
Lakehead University			2
McGill University	11		
McMaster University	3		
Memorial University of Newfoundland		7	
Queen's University	8		
Royal Military College of Canada	N/A		
The University of British Columbia	7		
The University of Western Ontario	2		
Toronto Metropolitan University		5	
University of Alberta	10		
University of Calgary	5		
University of Manitoba	4		
University of New Brunswick		2	
University of Northern British Columbia			1
University of Ottawa	9		
University of Saskatchewan	1		
University of Toronto	12		

University of Victoria		8	
University of Waterloo		9	
University of Windsor		1	
York University		6	
2019 Maclean's October 3, "Canada's best universities by student satisfaction: Rankings 2020," Macleans.ca, https://macleans.ca/education/canadas-top-school-by-student-satisfaction-2020/ (accessed Jan. 25, 2024).			

Maclean's Magazine had listed out the student satisfaction ranking of the Canada's best universities within 3 categories as Medical/Doctoral, Comprehensive, and Primarily. Rankings within the 25 approved universities have been concluded in the chart.

According to the *A roadmap for federal action on student mental health*, it has stated a survey done by Queen's University about mental health issues in post-secondary schools here in Canada. The results presented a significant need of concerning about students' stress levels, which is "90% of respondents stated that they experienced stress in the course of their studies – 30% reported average stress levels, 40% reported above-average levels, and 20% qualified their stress levels as tremendous" (Bartlett, 2014). As a consequence of the stresses, the outcomes could be but not limited to mental health problems, decreased academic performance, ill health, and missed school or work.

Those stresses can be caused by multiple factors including academic demands, financial challenges, social and peer pressure, and lack of support (Abdi, 2023). To address that, most of the Canadian universities have set up their mental care department. For example, the "Campus Wellness" by UWaterloo, "Wellness Hub" by McGill, "Wellness Platform" by UBC, and "Student Life Hub" by UofT. But these university-run services do not seem to work perfectly as "only 20% of students have been able to receive psychological or mental health services from their university" (Drolet & Sarabia, 2020). Introducing a range of policy adjustments tailored to accommodate the diverse needs of students in engineering has the potential to create engaged students. It is important to meet the needs of students to support academic student success.

In the meantime, the federal government is also focusing on the mental health crisis of post-secondary students. In 2023, the "Government of Canada invests nearly $4 million to OCAD University to support mental health of students." (Public Health Agency of Canada, n.d.)

Conclusion

Most of the universities offer general first year that provides a broad curriculum to students from diverse backgrounds while non-general first year provides a specific course to engineering subjects. Promotion rules across universities vary, with most requiring a 60% passing term cumulative grade. Some universities have a different variation of promotion rules, emphasizing

the institution's different academic standards. There is no obvious correlation between General First Year and Non-general First Year, Promotion Rules, and Universities Reputation.

While analyzing student retention and the cause leading to a student decision to leave university without finishing their degree, there is link between students' sense of belonging and their staying at university. When asked, students who felt less like they belonged at their university struggled more with their academic performance. Studies done from Carlton University strongly suggest that with more attention given to a student struggling with transition into university or from one term to another, it increases a student's ability to handle these situations. Later studies saw an increase in student retention. In conclusion, without any other driving factors, such as health or financial, a student's ability and want to stay in university comes down to their capability to handle university. A recommended way to increase student retention is to increase student connection and confidence with the university they are attending.

In conclusion, addressing the increasing mental health challenges faced by Canadian undergraduate students is an urgent priority. Collaboration between universities, provincial, and federal authorities is crucial to implementing effective support programs and fostering a more inclusive campus environment. The study's findings, revealing no apparent connection between promotion requirements, retention rates, and satisfaction levels, underscore the complexity of the issue. Additionally, the inverse relationship between student satisfaction levels and overall world university ranking suggests a need for a comprehensive understanding of factors influencing student well-being.

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