



ONCAT Project 2017-32
Identifying Historic Variables of Success for
Engineering Transfer Students
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Participating Institution

Lakehead University

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Executive Summary

Lakehead University occupies a unique position with respect to transfer programs for Engineering students within the province of Ontario. For more than 50 years, Lakehead has been offering both Engineering diploma and degree credentials, the latter designed purposefully to integrate diploma graduates in block transfer programming.

A diploma in Engineering technology was first offered at the Lakehead College of Arts, Science and Technology in 1957. In the late 1960s, a unique degree credential was introduced that built directly on this foundation. Remaining true to its roots of vocation-based technical engineering, the post-diploma Engineering Transfer Program is one of the longest standing block transfer pathways in Ontario in any discipline. Student enrolment in the transfer program has averaged over 500 students a year for the last five years.

The number of students and the age of the program has resulted in a rich legacy of data that can guide the development of best practices as we move into an era of greater student mobility informed by student and societal expectations.

New analytical techniques that are designed to deal with big data sets and are capable of merging qualitative and quantitative information such as Structural Equation Modelling and Machine Learning Algorithms, including Self Organizing Mapping, provide powerful tools to help us identify key indicators of trends relating to transfer, variables in transfer student success and overarching themes in relation to post-secondary student mobility.

While the overarching goal of this project was to identify variables of success for block transfer students in Lakehead University's Engineering Program, in gathering and analyzing over ten years of historic data that included multiple variables at various stages of the students' participation in the Engineering Transfer Program at Lakehead, the Project Team also identified opportunities and lessons learned to inform ongoing data collection and analysis related to transfer students at Lakehead University and more broadly throughout the Ontario system.

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Introduction

In 2012, Lakehead was tied with Ryerson as having the largest proportion of Ontario transfer students compared to their share of the Ontario system full time students¹. Transfer students are often divided into multiple groups, such as block transfer, advanced standing, and “other” transfer groupings. Students who are considered block transfer students receive advance standing for a grouped set of courses at the receiving institution based on their established equivalence at the sending institution. This allows them to enter a new institution at an advanced level².

While Lakehead University has multiple programs which classify as block transfer pathways, the longest standing program with the highest enrolment is Lakehead’s post-diploma Engineering Transfer Program which has seen nearly 300 new students enroll in recent cohorts³. Block transfer students enrolled in the Engineering Transfer Program at Lakehead experience higher retention and graduation rates than transfer students in other programs⁴. Lakehead has also found that transfer students enrolled in the Engineering Transfer Program experience higher retention and graduation rates than direct entry students, and achieved higher average grade point averages (GPAs) than direct entry students⁵.

While the success of Lakehead University’s Engineering Transfer Program is clear, the factors that determine student success in the program have not been empirically proven. This project sought to identify variables of success for transfer students in Lakehead’s Engineering Transfer Program, with the goal of helping to inform factors that may contribute to the success of transfer students in other programs at Lakehead University, while also informing variables for success for transfer students more broadly.

While the overarching goal of this project was to identify variables of student success for block transfer students in Lakehead University’s Engineering Programs, it was accomplished through a series of steps as outlined below:

- Retrieving, organizing and defining all historical and current data sets related to Engineering block transfer students at Lakehead University that are available and can be made functional, resulting in a longitudinal dataset.
- Defining variables contributing to student success and student risk through a review of literature, the project data set and past ONCAT funded projects.
- Analyzing the amalgamated data set with a focus on identifying trends in variables related to transfer student success and overarching themes in the evolution of student mobility in Ontario.
- Disseminating results and findings within Lakehead University and project stakeholders (ONCAT) to inform future studies on predictors of student success, particularly in relation to STEM-based block transfer pathways.
- Contributing best practices to the current and evolving body of knowledge on student mobility, especially in those areas supported by ONCAT funded initiatives.

¹ Lakehead University, Office of Institutional Analysis. Student success after transfer from college to Lakehead University. 2012.

² ONTransfer. "ONTransfer.ca: Glossary". https://www.ontransfer.ca/index_en.php?page=glossary Retrieved July 17th, 2017.

³ Lakehead University, Faculty of Engineering. Engineering Newsletter. <https://www.lakeheadu.ca/sites/default/files/uploads/91/Jan%202017%20Newsletter.pdf> Retrieved July 19th, 2017.

⁴ Lakehead University, Office of Institutional Analysis. Student success after transfer from college to Lakehead University. 2012.

⁵ Lakehead University, Office of Institutional Analysis. Student success after transfer from college to Lakehead University. 2012.

Literature Review

The first step in this process was to conduct a literature review to identify “success” and related variables to inform data collection and related analysis.

Defining Success

Foundational Theories

Numerous theorists over the years have developed their works attempting to address the definition of student success. Some of the most influential theories are those by Astin⁶ and Tinto⁷. Milem & Berger describe the distinction between these two pivotal theorists as essentially the difference between psychological and behavioural variables. They cite Astin’s theory as being behavioural, defining involvement as the amount of energy, physical and psychological, that a student commits to their academic experience. This leads to persistence of students being related to the level and quality of interactions they have with peers, staff, and faculty. They summarize Tinto’s theory as expanding on involvement to include how involvement is related to learning. It is not enough to simply be involved, a student’s involvement must enhance their learning. According to Tinto, a student who is learning is more likely to persist. This adds a perceptual or psychological level to the concept of involvement. Tinto described a student as becoming integrated after they complete the navigation of a set of stages: separation, transition, and incorporation. Separation requires the student to dissociate to some degree from the norms of their past communities. Transition occurs after separation and entails the shift between the separation from old norms and adoption of new norms. Incorporation happens when the student adopts the new norms and behaviours of their academic community. This has resulted in a number of factors that influence a student’s decision to leave the institution, such as academic difficulty, adjustment problems, lack of clear academic and career goals, uncertainty, lack of commitment to a goal or institution, poor integration with the college community, incongruence, and isolation. Conversely, retention is influenced by interaction with faculty and staff and institutional and goal commitment. Retention can be understood in terms of a student’s integration into the social and academic environment of an institution. The more connected a student is to the social and academic fabric of a campus, the more likely he or she is to persist in college. The importance of integration and involvement in academics and life outside the classroom is shared by multiple theories of student involvement and success. However, while these theories have been largely influential, they are not without criticism.

Milem and Berger conducted a study that attempted to integrate the perceptual and behavioural measures often used in previous studies and found that involvement was the best predictor of later involvement and that those students who were not engaged early on tended to remain not engaged over time. Their results led them to the conclusion that academic integration did not predict institutional commitment, which had little variation and tended to remain steady over time, or the student’s intent to re-enroll. Only social integration predicted

⁶ Astin, Alexander W. "Student involvement: A developmental theory for higher education." *Journal of college student personnel* 25, no. 4 (1984): 297-308.

⁷ Tinto, V. (1993) *Leaving college: Rethinking the causes and cures of student attrition research* (2nd ed.) Chicago: University of Chicago.

both institutional commitment and intent re-enroll. Following their combined theoretical model, academic integration should have also predicted these outcomes⁸. Other researchers have made some important criticisms of Astin and Tinto's theoretical models that may elucidate these findings.

Hurtado and Carter⁹ criticize Tinto's theoretical assumptions, particularly as they are applied to students from diverse backgrounds. They note that social integration will be different for students from diverse backgrounds and challenge Tinto's requirement of a separation from previous ties. They cite previous research which makes this presupposition contradictory; peer groups can form in response to shared recognition of a problem to be solved. This implies that peer groups can form in contrast with conformity to the dominant culture of the institution. Therefore, a student can become integrated with their peers without completely setting aside their values for those of the institutions. They note that researchers attempting to measure integration have no clear means to do this and instead measure participation through variables such as effort or time spent in specific activities, perceptual measures, reported behavioural measures, interpersonal relationships, satisfaction with academic and social environments, and objective performance measures. These measures have been shown to correlate with persistence and other desirable outcomes in numerous studies, but are not necessarily evidence of integration as it is purported in Tinto's theoretical construction. They condense this as Tinto's theoretical construct of integration lacking a distinction between participation and membership, which can be related but do not have to be. They conclude with the important distinction between attitudinal and behavioural belonging; students can feel they belong in an environment without obvious participation in the environment, or conversely, they can have evidence of participation in an environment without fostering a sense of belonging. This is an important distinction researchers must account for when studying students' integration or belonging, and is reminiscent of Milem and Berger's point that some of the prevalent theories of student success do not adequately account for both perceptual and behavioural components.

New Directions

Some more recent theorists have stepped away from testing these foundational theories and attempted to describe different aspects of the transfer experience in order to identify pivotal points that determine transfer students' decision to continue or leave their studies. A concept that can reflect both the previous leading theoretical constructs and the more recent shift to focusing on the transfer experience is that of "transfer shock". Originally, this referred to the decrease in a student's GPA immediately following transferring from a college to a university. More recently it has come to refer to not only a shift in GPA but also the cultural adaptation transfer students must acclimate to¹⁰. Flaga¹¹ described five sequential phases of the transfer experience; Learning Resources, Connecting, Familiarity, Negotiation, and Integration. Students' progress from learning the available resources and connecting with them, to being familiar with them. Finally, they are able to use the resources to help them negotiate problems.

⁸ Milem, Jeffrey, F. & Berger, Joseph B. A Modified Model of College Student Persistence: Exploring the Relationship Between Astin's Theory of Involvement and Tinto's Theory of Student Departure. *Journal of College Student Development*, 11(1997). pp. 387-400.

⁹ Hurtado, Sylvia, and Deborah Faye Carter. "Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging." *Sociology of education* (1997): 324-345

¹⁰ Gerhardt, Kris, and Michael Ackerman. "Postsecondary Student Mobility from College to University: Student Expectations and Experience." *College Quarterly* 17, no. 1 (2014): n1.

¹¹ Flaga, Catherine T. "The process of transition for community college transfer students." *Community College Journal of Research and Practice* 30, no. 1 (2006): 3-19.

Eventually, they may experience integration where they feel as though they are a part of their post-secondary institution. Other theories have similarly tried to account for the gap between perceptual and behavioural components, often with the concept of student engagement.

Kuh¹² defines student engagement as the time and effort students devote to activities that are empirically linked to desired outcomes of college and what institutions do to encourage students to participate in these activities. Theories of engagement helped to formulate the National Survey of Student Engagement (NSSE) measures. Outcomes in research have included cognitive development, psychosocial development, self-esteem, and locus of control, moral and ethical development and persistence, student-faculty contact, active learning, prompt feedback, time on task, high expectations, respect for diverse learning styles, and cooperation among students. Engagement also can be related to how the institution allocates its resources and arranges its curricula, other learning opportunities, and support services to encourage students to participate in activities positively associated with persistence, satisfactions, learning, and graduation. NSSE benchmarks include academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experiences, and supportive campus environment. Another important concept in engagement research is high-impact activities, such as first-year seminars, learning communities, writing-intensive courses, common intellectual experiences, service learning, diversity experiences, student-faculty research, study abroad, internships and other field placements, and senior capstone experiences. Learning community students interacted more with faculty and diverse peers, studied more, and engaged more frequently in higher order mental activities such as synthesizing material and analyzing problems; they report higher levels of academic challenge and contact with faculty when instructors create assignments that require students integrate across the multiple courses associated with the learning community. Engagement has been a more recent foundational theory that has shaped student success research. Henderson¹³ argues for engagement as success by suggesting that engagement outside the classroom can lead to engagement in the classroom, especially if tied to “aha moments” that connect co-curricular to classroom learning. Facilitating these moments and ensuring achievements are officially recognized encourages engagement. Attrition has often been cited as being for a variety of academic, financial, or personal reasons and this can be considered placeholders for a student’s perception they are not getting enough value for the time, money, and effort they are investing. Thus, institutions can build value to encourage student to stay by implementing assessable learning outcomes into the co-curriculum. While many of these theoretical approaches have explanatory value, ultimately translating a theoretical approach into measurable outcomes can be challenging.

Measuring Success

When measuring success, studies often assess behavioural or attitudinal variables. Behavioural variables are used more frequently as they are often available within the student information system. Attitudinal variables usually require survey methods, which are costly, time consuming, and often hard to generalize. Using available data for attitudinal variable proxies requires assumptions to be made. For example, students engaged with support services could be seen as less academically prepared, or more academically committed. Further, to measure student characteristics, specific time frames of interest must be identified. Some

¹² Kuh, George D. "What student affairs professionals need to know about student engagement." *Journal of college student development* 50, no. 6 (2009): 683-706.

¹³ Henderson, Stanley E. "SEM and the Student Journey: The Role of Strategic Enrollment Management in Student Engagement." *Strategic Enrollment Management Quarterly* 4, no. 4 (2017): 144-155.

demographic characteristics, and certainly a number of academic characteristics, can change through the duration of time the student is engaged with the institution. Therefore, it can be helpful to categorize variables of interest according to time periods of interest.

Entering Variables

Some studies suggest students' motivations must be considered in order to define success. For some students, graduating is not the goal. Henderson¹⁴ found motivational and demographic differences between four applicant groupings; college applicants who aspired to university after college, college applicants who did not aspire to university after college, university applicants with previous college credential, and university applicants with no previous post-secondary experience. They found distinct differences between these groups. College to university transfer students have a relatively larger proportion of traditionally underrepresented groups compared to those entering university from high school, were less likely to have a high school academic average of 85%+ and were less likely to have taken university prep courses in high school. Non-aspirants and transfers were more likely to cite proximity of institution as a deciding factor. Shook, Norman, & Guyatt¹⁵ found related demographic differences. They found a major cultural difference for transfer students was the proportion of students who are able to work as many hours and still do well academically shifts from college to university. This is doubly impacted by the increased financial burden of university level studies. A higher proportion of transfer students receive OSAP and a lower proportion (42%) had a parent who had attended university. 82% said they entered their college program with the intention of transferring to university. Kuh¹⁶ notes that precollege characteristics such as ACT and SAT scores are strong predictors of first-year grades and persistence; however, once college experiences are taken into account, such as living on campus, enrollment status, working off campus, and so forth, the effects of precollege characteristics and experiences diminish considerably. The college experiences that matter most to the desired outcomes are those that engage students at high levels of educationally purposeful activities. The students at greatest risk of leaving college sometimes after the second year are almost identical in terms of demographic characteristics to those who leave before that point. Singell and Waddell¹⁷ found this to be the case as well; high school grades lost a lot of their predictive power once college grades were available, and students who were identified to be at risk early on typically continued to be at risk throughout their time at the institution. This may be due partially to immovable demographic characteristics, such as those found by Finnie and Qui¹⁸ to be related to success; age, gender, and family background. While these variables may change as a

¹⁴ McCloy, Ursula. "From Application and Beyond: Tracking Aspirations, Motivations, Experiences, and Outcomes of Ontario's Transfer Students." (2017).

¹⁵ Shook, Cheryl, Curtis Norman, and Jennifer Guyatt. "Assessing Determinants of Academic Success for College to University Transfer in the Diploma to Degree Program, Woodsworth College, Faculty of Arts and Science, University of Toronto." (2016).

¹⁶ Kuh, George D. "What student affairs professionals need to know about student engagement." *Journal of college student development* 50, no. 6 (2009): 683-706.

¹⁷ Singell, Larry D., and Glen R. Waddell. "Modeling Retention at a Large Public University: Can at-Risk Students Be Identified Early Enough to Treat?" *Research in Higher Education* 51 no. 6 (2010): 546-72. doi:10.1007/s11162-010-9170-7.

¹⁸ Finnie, R., and H.T. Qiu. 2008. Is the Glass (or Classroom) Half-Empty or Nearly Full? New Evidence on Persistence in Post-Secondary Education in Canada. In *Who Goes? Who Stays? What Matters? Access and Persisting in Post-Secondary Education in Canada*. Eds. R. Finnie, R.E. Mueller, A. Sweetman, and A. Usher. Montreal and Kingston: McGill-Queen's University Press

student progresses through their program of study, multiple studies have evidenced that entering variables are related to student success, especially in their first year.

Further entering variables that are important predictors of success have to do with the student's experience entering the institution. This can include the actual application process, course enrolment, and other logistics of becoming a student. A particularly important component of this for transfer students is how their transfer credits are handled. Monaghan & Attewell¹⁹ carefully matched groups of transfer students to direct 4-year institution entrants and found an overall difference in BA attainment rate of 17 percentage points. The risk was highest for those transfer students who had less of their credits recognized by the receiving institution: nearly 14% of transfers essentially started anew. Those who had all of their credits transferred were 2.5x more likely to graduate than those who had less than half of their credits transferred while those who had between 50% and 89% of their credits transferred had 74% higher odds. This echoes results in the Best Practices in Bridging²⁰ study in which student interviews revealed that nonspecified transfer credits impeded their academic mobility, as well results from Douglas & Attewell²¹ who demonstrated avoiding remedial coursework improved retention likelihood. Here, an aspect of entering the institution, such as transfer credits awarded, clearly influence the student's experience as they are enrolled in the institution.

Enrolled Variables

Once a student is enrolled, a number of new factors begin to influence their decision to remain in their program of study. Some of these variables include their academic characteristics, but what resources they use to help them academically and the social supports they have are also important. Transfer students were found to be more likely to use financial aid and personal counseling while those with no previous post-secondary experience (PSE) were more likely to use recreation facilities and orientation programs²². The Best Practices in Bridging Study²³, conducted at Lakehead University in 2016, echoed that transfer students are more likely to turn to faculty, friends, and alumni as primary sources of information and support. Transfer students are more likely to participate in classroom discussions and more likely to discuss their assignments or grades with instructors, discuss ideas and career plans with faculty members; those with no previous PSE were more likely to participate in on-campus community service or volunteer activities, student clubs or special interest groups, attend campus cultural events²⁴. Monaghan & Attewell²⁵ interviewed transfer students at different points in their journey through transfer and found that academic challenge and connection is fundamental to transfer student engagement. Transfer students are more likely to have other obligations that keep them away from campus, and are more likely to see social gatherings as an unnecessary distraction.

¹⁹ Monaghan, D. B., & Attewell, P. The Community College Route to the Bachelor's Degree. *Educational Evaluation and Policy Analysis*, 37 no. 1, (2015): 70-91.

²⁰ Lakehead University, "Transitioning to University: Best Practices for College Transfer Bridging Courses Final Report". (2016).

²¹ Douglas, Daniel, and Paul Attewell. "The bridge and the troll underneath: Summer bridge programs and degree completion." *American Journal of Education* 121, no. 1 (2014): 87-109.

²² McCloy, Ursula. "From Application and Beyond: Tracking Aspirations, Motivations, Experiences, and Outcomes of Ontario's Transfer Students." (2017).

²³ Lakehead University, "Transitioning to University: Best Practices for College Transfer Bridging Courses Final Report". (2016).

²⁴ McCloy, Ursula. "From Application and Beyond: Tracking Aspirations, Motivations, Experiences, and Outcomes of Ontario's Transfer Students." (2017).

²⁵ Monaghan, D. B., & Attewell, P. The Community College Route to the Bachelor's Degree. *Educational Evaluation and Policy Analysis*, 37, no. 1 (2015), 70-91

Students who felt academically engaged felt socially engaged. Activities typically conceptualized as engagement by those who study transfer students, such as attending office hours or asking an instructor additional questions about material were not seen as engagement by transfer students but as normal parts of course taking. They reported feeling high levels of engagement when faculty created opportunities for more meaningful interactions. Part-time enrolment was found to be negatively related to engagement. That transfer students define engagement differently makes NSSE results suggesting they are less engaged both accurate and irrelevant. Singell & Waddell²⁶ found results that support this as well, as transfer students who take heavier course loads in their first term are actually more likely to return the following term. Ultimately, transfer students are motivated and engaged by different factors than other types of students.

Allen, Robbins, and Casillas²⁷ studied the effects of academic performance, motivation, and social connectedness on third-year retention, transfer, and drop-out behaviour and found these variables differ for retention and transfer outcomes. Academic performance was found to have large effects on likelihood of retention and transfer. Academic self-discipline, pre-college academic performance, and pre-college educational development were found to have indirect effects on retention and transfer. Finally, college commitment and social connectedness were found to have direct effects on retention. They cite past research displaying that remedial instruction has short and long-term benefits on persistence, that supplemental instruction improves fall-to-fall persistence, and that persistence rates are consistently higher for participants in Freshman Year Experience seminars. Finally, they note that academic advising programs appear to influence the likelihood of staying. Their results are supported by a meta-analysis and helped to inform the development of the ACT ENGAGE scale. Some important things to consider when measuring academic performance have been outlined by other researchers. Stewart and Martinello²⁸ note that using GPA change is an inconsistent measure because different institutions have different standards. They suggest instead course withdrawal before completion and academic outcome for those who failed the first term or year of courses. They also used number of credits attempted compared to those completed, GPA over enrolment terms, total number of course withdrawals, and degree attainment by a certain year (3-4 years after enrolment). Further, Singell and Waddell²⁹ note that GPA should be compared to averages for the specific course where possible, or even the general subject area. Delen³⁰ found fall GPA to be the strongest predictor, followed by earned/registered credit ratio, fall student loan receipt, spring student loan receipt, admission type, and SAT scores. The rest of their tested variables were similar in their level of influence until high school GPA, concentration specified, sex, and years after high school, which had very little predictive power. Suggestions for inclusion that were not possible in their study include data on student's social interactions, student's expectations entering to the institution, and student's parent's financial and educational background.

²⁶ Singell, Larry D., and Glen R. Waddell. "Modeling Retention at a Large Public University: Can at-Risk Students Be Identified Early Enough to Treat?" *Research in Higher Education* 51, no. 6 (2010): 546–72. doi:10.1007/s11162-010-9170-7.

²⁷ Allen, Jeff, Steven B. Robbins, Alex Casillas, and In-Sue Oh. "Third-year college retention and transfer: Effects of academic performance, motivation, and social connectedness." *Research in Higher Education* 49, no. 7 (2008): 647-664.

²⁸ Stewart, J., and Felice Martinello. "Transfer Students in Ontario: How are they faring?" (2012).

²⁹ Singell, Larry D., and Glen R. Waddell. "Modeling Retention at a Large Public University: Can at-Risk Students Be Identified Early Enough to Treat?" *Research in Higher Education* 51 no. 6 (2010): 546–72. doi:10.1007/s11162-010-9170-7.

³⁰ Delen, Dursun. "Predicting student attrition with data mining methods." *Journal of College Student Retention: Research, Theory & Practice* 13, no. 1 (2011): 17-35

Exiting Variables

Different approaches can be taken to measuring exiting variables of success. For example, graduation rates and time to completion for four-year degrees are typically measured in six- or seven-year increments. This allows for a timeframe of approximately 200% of the time it is expected to take to complete a program³¹. In a previous study³², transfer students were compared with upper-year students, as students entering second or third year after beginning university as direct entry students are likely more comparable to transfer students than those entering first year. Exiting variables are often program specific, and this extends to transfer programs which have varying entry points, requirements, and expected lengths.

Conclusion

Lakehead University's Engineering Post-Diploma program has a record of producing successful transfer students. The Best Practices in Bridging³³ study found through qualitative analysis that students experience summer bridging as inducing transfer shock and that helps them to determine whether they were well suited for the culture of the program. Bridging provided time for students to become accustomed to available academic supports, get to know their cohort, and participate in an orientation experience specific to students like them. These students' success supports the calls of researchers such as Martinello and Stewart³⁴ who assert that transfer students miss out on the support and resource introduction of the first two years at university established through introductory level projects and courses. They assert that supports designed to initiate these upper year students to this culture bridge the gap they face and help to ensure their success. A fortunate challenge of this study will be that the majority of transfer students are ultimately successful. This may mean comparing groups will require not just comparing those who are successful to those who are not, but creating a continuum of success in which to make comparisons.

Environmental Scan

Following the literature review, a number of variables of interest were identified that the Project Team wanted to explore further.

This list of variables was checked against potential sources of data including Lakehead University's student information system, OUAC application data, internal application files, and other relevant campus organizations and administrative offices including student clubs, the Student Success Centre, Student Awards and Financial Aid, and the Alumni Association. Through this process, the Project Team refined the list of variables, based on availability, robustness, and objectivity of the data.

The refined list of variables formed the basis of consultation with the Faculty of Engineering. During the consultation, the Faculty identified substantial program requirement changes in 2004, recommending the data set for this initiative focus on 2004 to present.

The output of this consultation informed the following table, which outlines variables considered for inclusion in the analyses, the findings regarding their availability for the cohorts of

³¹ Ontario Ministry of Training, Colleges and Universities. (2012). Graduation Rate KPI Calculation and Reporting for the 2011-12 Reporting Year.

³² Lakehead University, Office of Institutional Analysis. Student success after transfer from college to Lakehead University. (2012).

³³ Lakehead University "Transitioning to University: Best Practices for College Transfer Bridging Courses Final Report". (2016).

³⁴ Martinello, Felice, and Jo Stewart. "Transfers from College to One Ontario University: A Four-Year Outcome Study." *The Canadian Journal of Higher Education* 45, no. 1 (2015): 18-36.

interest entering between 2004 and 2016, and the decision to either include or exclude the variable in the data set.

Variables Identified in Environmental Scan

Entering Variables Demographic	
Variable of Interest	Decision
Age	Include
Gender	Include
First language	Include
Geographic origin	Include
First generation status	Include
Indigenous status	Include
Marital status	Include
Past employment/activities	<i>Exclude</i>
Dependents	<i>Exclude</i>
Socio-economic status	Include
Academic motivation	<i>Exclude</i>
Definitions and Findings	
<p>The demographic variables of age, gender, first language, geographic origin, first generation status, indigenous status, and marital status are regularly collected, self-reported variables for which a historical data set was readily available. Past employment and activities were considered for inclusion, as OUAC application data contains some information on these variables. However, upon reviewing a sample of this data, the variation was determined to be too great to inform meaningful conclusions. The variables of academic motivation and dependents were considered of interest but were not regularly collected. A proxy for socio-economic status was developed based on the students' postal code at time of admission in combination with income data available through Statistics Canada.</p>	
Entering Variables Education – Past	
Variable of Interest	Decision
Sending institution	Include
Sending program	Include
College marks	Include
Admission average	Include
Time since graduation	Include
Institution preference	Include
High school characteristics	<i>Exclude</i>
Definitions and Findings	
<p>Institutional preference was determined through OUAC application data which indicates an applicant's first choice and how many institutions the student forwards their application to. The sending institution variables including institution name, sending program, sending marks, and previous credential completion date were combined from a combination of paper transcripts and electronic transcripts received through the Standardization of Postsecondary Education Electronic Data Exchange (SPEEDE) server system. Working with Lakehead's ERP professionals, the researchers were able to develop a method for pulling large amounts of SPEEDE transcript data from the student information system. The admission average, which is the average mark used as basis for admission, was captured in a mixture of both paper and electronic internal admission files.</p>	
Entering Variables Education – Present	

Variable of Interest	Decision
Required transition courses	Include
Entry period	Include
Expected time to completion	Include
Financial aid status	<i>Exclude</i>
Definitions and Findings	
<p>Transition courses are determined on a personalized basis depending on the student's academic background. These required courses are recorded on paper admission files. Lakehead offers two entry periods for this particular transfer program; the summer term and the fall term. Due to practical considerations, these entry experiences are different and thus were identified as variables of interest. Expected time to completion was calculated dependent on these entry periods, as those who enter in the fall are less likely to finish within the three-year time frame. Expected time to completion was determined as 5 years for spring entry students and 6 years for fall entry students. Financial aid status was explored as a variable of interest, however the criteria for OSAP and other award disbursement was found to have changed multiple times during the study period - thus, it was decided this was not an appropriate variable for this historical study.</p>	
Enrolled Variables	
Grades	
Variable of Interest	Decision
Marks in transition courses	Include
Marks for major courses	Include
Marks for service courses	Include
Marks at the basic skills level	<i>Exclude</i>
Definitions and Findings	
<p>Consultation with the Faculty of Engineering identified that program requirements dictate different marks for different types of courses. For example, some of the transition required courses only require a passing grade of 50%, while many major courses require a passing grade of 70%. Understanding program requirements such as this, which are variable for each program, are an important consideration when using marks data as a measure of success. Thus, methods were adjusted to consider marks for transition courses, service or non-major courses, and major courses separately. While marks at the basic skill level, such as exams or projects, were considered of interest, it was determined there was not enough historical consistency to include this data in this study.</p>	
Enrolled Variables	
Enrolment Characteristics	
Variable of Interest	Decision
Full or part time status	Include
Course repeats	Include
Residence status	Include
Financial aid/awards	<i>Exclude</i>
Support service usage	<i>Exclude</i>
Club participation	<i>Exclude</i>
Employment	<i>Exclude</i>
Satisfaction	<i>Exclude</i>
Definitions and Findings	
<p>Course enrolment data, including full and part time status, whether a course was taken as a special exam, and whether a course was repeated, was pulled from the student information system and coded with flags. Similarly, residence status for each term of enrolment was added to the database. As explained above, financial aid data was determined not to have a level of desired consistency for application to the historical cohorts included in this study. Support service usage and club participation were explored as a possible measures of student engagement, however differing levels of data collection in these services and clubs lead to the determination that a fair representation of engagement using these measures</p>	

could not be considered, especially historically. Employment and satisfaction measures are often used from survey data regularly collected, such as NSSE and OUGS, however, it was determined that sometimes the program specifics could not be determined. In some cases, these outcomes could be determined for Engineering students in general, but not engineering transfer students in particular. Further, this survey data is often a sample of eligible students, and is collected on rotating cycles, which does not readily correspond to the year by year cohort study in question.

Enrolled Variables

Program Characteristics

Variable of Interest	Decision
Program type	Include
Co-op participation	Include
Academic probation	Include
Academic goals	<i>Exclude</i>
Academic mobility	<i>Exclude</i>
Engagement	<i>Exclude</i>

Definitions and Findings

Program type refers to which stream of engineering the student enrolled in, whereas co-op participation was reduced down to whether or not the student ever enrolled in a co-op stream. Co-op participation details were explored, but over the historical study period co-op detail data was too variable for inclusion. Academic probation was defined based on the student's grades falling below a certain level based on program requirements. Academic goals and mobility were considered as variables of interest based on literature, however, this data would require consistent survey collection which does not currently exist. Similar to as explain above, engagement measures were not descript enough in terms of program or prevalent enough in terms of historical coverage.

Exiting Variables

Graduating

Variable of Interest	Decision
Time to completion	Include
Graduating GPA	Include
Graduate level studies	<i>Exclude</i>
NSERC awards	<i>Exclude</i>
Alumni engagement	<i>Exclude</i>
Employment outcomes	<i>Exclude</i>

Definitions and Findings

Time to completion was calculated based on allowing students approximately two years over the expected program time to complete the program, based on the standard for reporting graduation rates. This was different for spring and fall entry students as outlined previously. Whether or not the student continued on to pursue graduate studies was considered as a success measure, however data was not available for students who chose to continue at another institution, and Lakehead had experienced changes in graduate admissions/regulations during the sample period, resulting in the Project Team excluding graduate level studies and NSERC awards from the data set. For similar reasons, specifically changes in methodology during the sample period, employment outcomes and measures of alumni engagement were determined to not be robust enough to apply to the historical cohorts.

Exiting Variables

Withdrawing

Variable of Interest	Decision
Time spent in program	Include
Exiting GPA	Include
Program change	Include
Alumni engagement	<i>Exclude</i>

Employment outcomes	<i>Exclude</i>
Definitions and Findings	
<p>Many variables for exiting students are similar to those for graduating students. In this case, the variables of GPA, the amount of time spent in the program, and whether or not the student changed programs were considered. A student who changed programs either within the Faculty of Engineering, or who chose to stay at Lakehead but to move to a different field of study, and remained enrolled at Lakehead for a number of terms should be considered differently than a student who took their summer transition courses, did not achieve required marks, and then left the institution.</p>	

Research Methodology

Data was collected for the variables outlined above by the Office of Institutional Planning and Analysis for the period 2004 – 2016 using a number of sources as referenced above. This data was fully anonymized by the Office of Institutional Planning and Analysis prior to analysis, using encrypted identifiers to link data sets.

The research team then applied a variety of structural equation modeling (SEM) techniques to explore a number of hypotheses related to student success measures on a sample of the dataset.

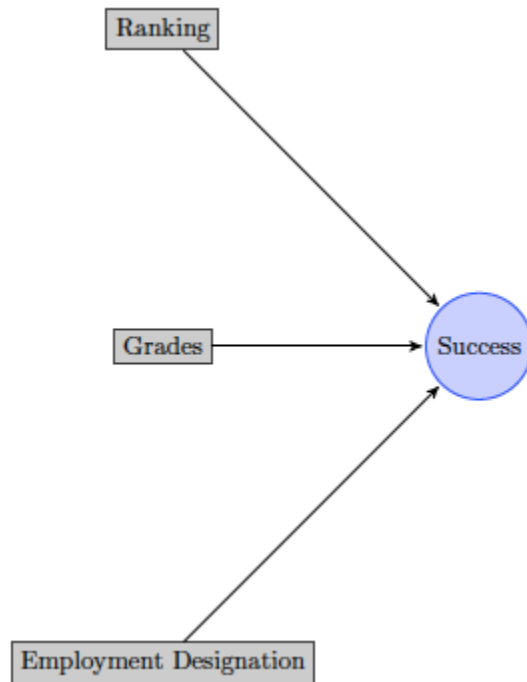
Success outcomes were determined to be the latent variables of academic performance and program completion. Latent variables are variables that are not directly observed but are implied from other observed variables. The latent variable of academic performance was estimated based on the combination of many directly observable variables, such as the various marks measures described above. The impact of manifest or exogenous variables, such as age and gender, on dependent or latent variables, such as success, is computed using path analysis or confirmatory factor analysis, which are SEM techniques which seek to describe the level of relationship between these variables. Path analysis deals with models in which all the variables are observed variables, whereas confirmatory factor analysis deals with unobserved variables combined into a higher level, latent variable.

Example of Path Analysis



In this example path analysis diagram, the directly measured and observed variables of motivation, workplace norms, and supervisor support are used to calculate a measure of work performance.

Example of Confirmatory Factor Analysis



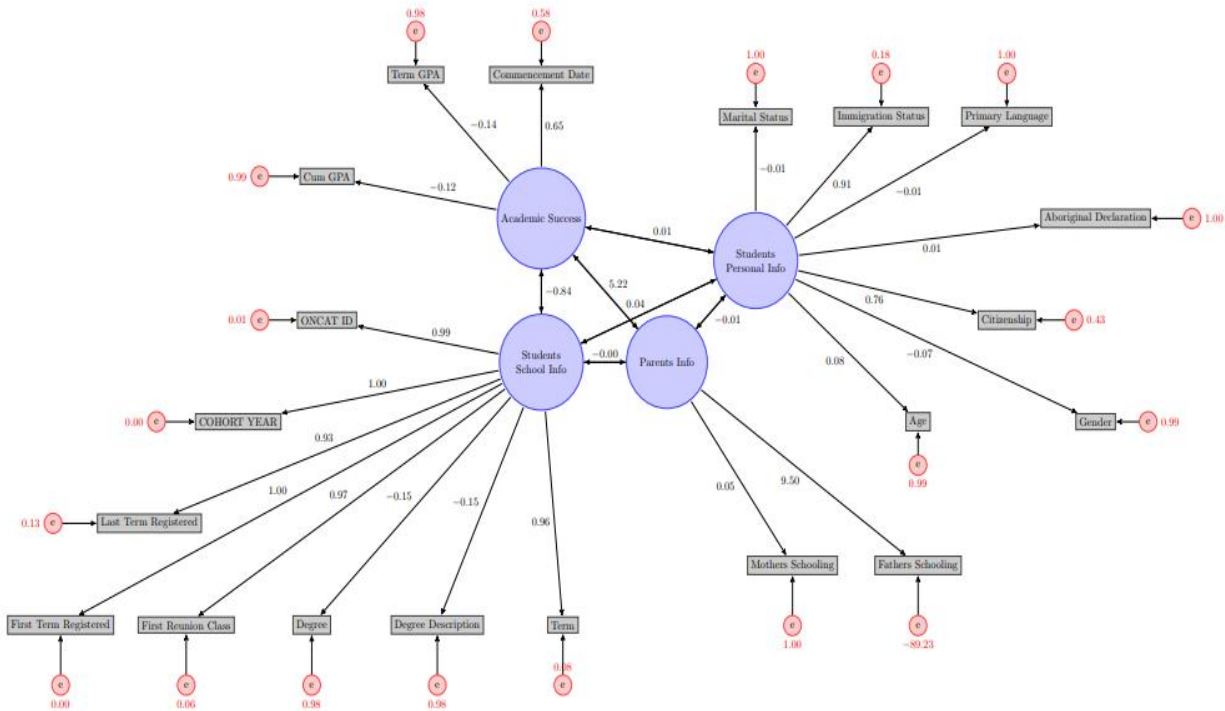
In this example of confirmatory factor analysis, the observed variables of ranking, grades, and employment designation, are used to estimate a measure of overall success, which then can be used in further analyses.

Hypotheses

A number of hypotheses were developed and investigated using structural equation modeling techniques outlined above. Six hypotheses, as outlined below, were reported on for the purpose of this Final Report. These hypotheses sought to describe the demographic and sending institution characteristics which may influence students' academic performance and their program completion.

1. Do marital status, age, and gender influence academic performance;
2. Do marital status, age, and gender influence on-time completion;
3. Do immigration status and first language influence grades;
4. Does the student's sending institution influence on-time completion;
5. Does the student's college grades predict their university academic performance;
6. Does the number of required transition courses effect academic performance.

Structural Equation Model developed based on above hypotheses



This model figure outlines how the variables collected and included in the database were ultimately used in structural equation modeling. Variables relating to each parent's educational levels were combined into a latent variable described as parent's education level. Directly measured variables such as age, grades, citizenship, primary language, immigration status, marital status, and aboriginal declaration were combined into a latent variable called students' personal information. The latent variable of academic success was calculated from the measured variables of term grades, cumulative grade point average, and commencement status and date. Other enrolment characteristics, including the cohort year, registration status, program details, and amount of time enrolled were combined into the latent variable of students' school information.

Following structural equation modeling techniques, a predictive model using machine learning algorithms was developed based on the entire dataset. A prediction model was built using machine learning algorithms and is hosted on the Amazon Web Services (AWS) Machine Learning platform. This platform hosts the prediction model, which operates in real-time based on end-user input. The Amazon machine learning algorithm learns the weights for the model. The weights represent the likelihood that the patterns that the model is learning reflect true associations in the data. This is arrived at through a multiclass classification algorithm which uses multinomial logistic regression and an optimization technique. The web application is using Flask as backend logic layer using Python programming language for web applications.

Results

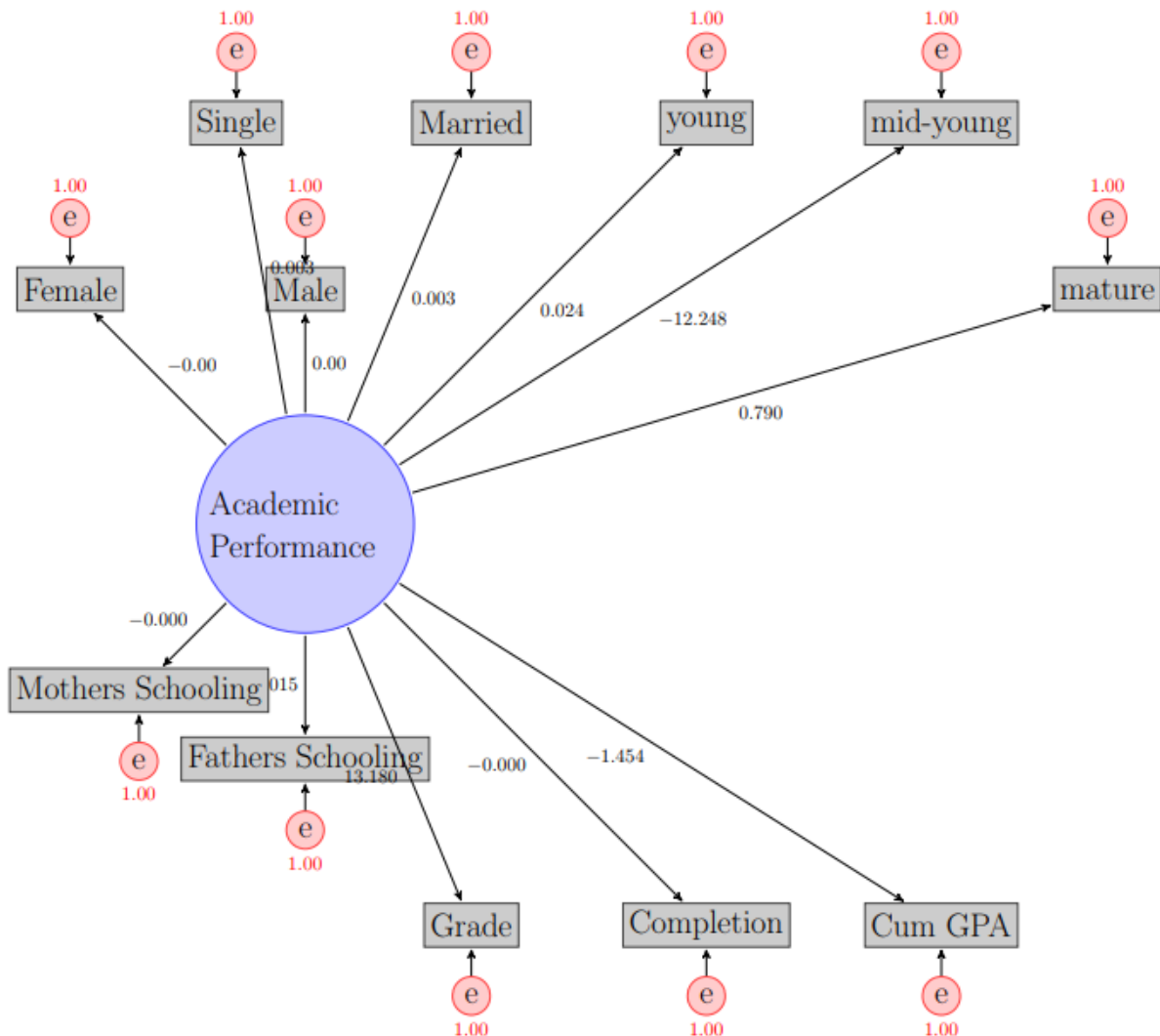
Hypothesis 1

Hypothesis 1 used a sample of students to determine through confirmatory factor analysis whether age, gender, and marital status were related to academic performance.

Descriptive Statistics

Characteristics	Number of Students	Percentage	Term Grade (Mean)
Age			
Age bracket 1 (18-20)	95	8.42%	66.59
Age bracket 2 (21-25)	793	70.36%	68.22
Age bracket 3 (26-50)	239	21.20%	68.68
Gender			
Male	1060	94.05%	68.23
Female	67	5.94%	67.52
Marital Status			
Married	69	6.12%	71.15
Single	1058	93.87%	67.98

Confirmatory Factor Analysis



	Estimate(β)	Std.Err	Std.lv	Std.all
Latent Variables:				
Academic Performance =				
Gender_Male	0.000	NA	0.000	0.001
Gender_Female	-0.000	NA	-0.000	-0.000
Married	0.003	NA	0.003	0.012
Single	0.003	NA	0.003	0.013
young	0.024	NA	0.024	0.075
midage	-12.248	NA	-12.248	-6.163
mature	0.790	NA	0.790	0.109
X_Fathr_Schlng	0.015	NA	0.015	0.005
X_Mothr_Schlng	-0.000	NA	-0.000	-0.000
Grade	13.180	NA	13.180	0.677
Completion	-0.000	NA	-0.000	-0.001
Cum_GPA	-1.454	NA	-1.454	-0.006
R-Square:				
Gender_Male	0.000			
Gender_Female	0.000			
Married	0.000			
Single	0.000			
young	0.006			
midage	0.000			
mature	0.012			
X_Fathr_Schlng	0.000			
X_Mothr_Schlng	0.000			
Grade	-48.850			
Completion	0.000			
Cum_GPA	0.000			

1. **Std.Err:** Standard Error
2. **Std.lv:** Standard Lavaan
3. **Std.all:** Standard all the variables.

df	p-value	RMSEA	SRMR	CFI	GFI	AGFI
46.000	0.000	0.623	0.221	0.074	0.674	0.447

The major indicators to accept the model are its standard RMSEA (SRMR), RMSEA, and CFI values which are estimated to be ≥ 0 and ≥ 0.90 for a good model fit. Another important index is the p value. The overall model is significantly acceptable (p-value = 0.000).

The results identified marital status was not a predictor of academic performance. Male gender was a predictor of academic performance, however, the sample sizes for male and female gender were largely unequal and suggest caution in interpreting comparisons. For age brackets, the youngest age bracket and highest age bracket were shown to be predictors of higher academic performance.

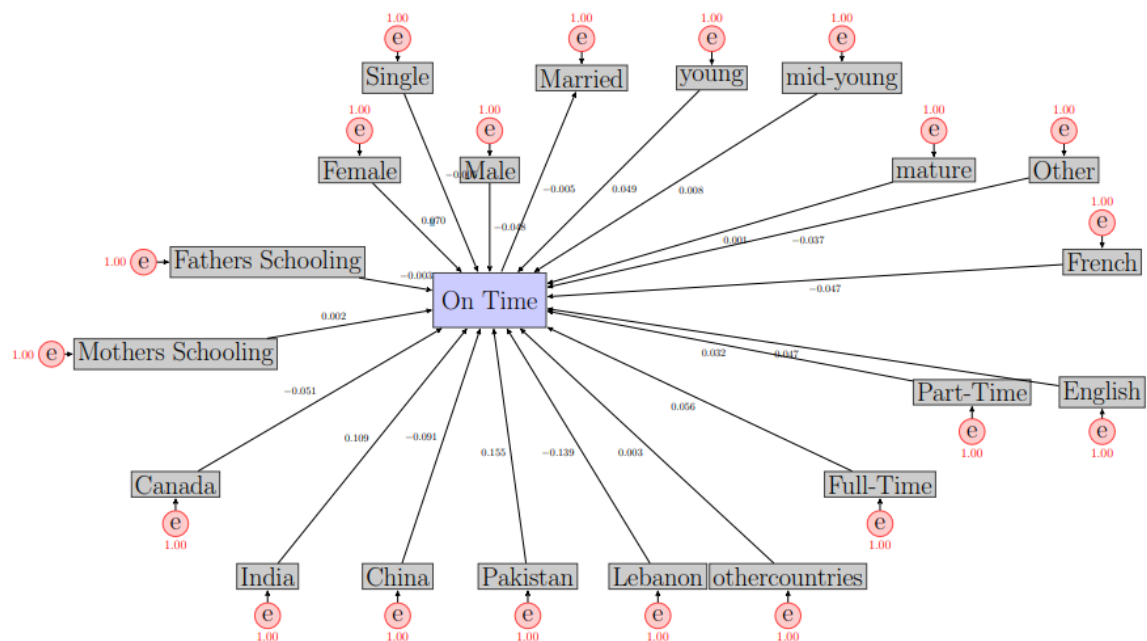
Hypothesis 2

In addition to variables used in hypothesis 1, the following variables were added to hypothesis 2, which used path analysis to determine whether the demographic variables of marital status, gender, and age affected on-time degree completion.

Descriptive Statistics

Characteristics	Number of Students	Percentage	Term Grade (Mean)
Degree Completion			
Completed, on-time	882	78.26%	69.73
Completed, over-time	11	0.97%	58.68
Did not complete	234	20.76%	53.50
First Language			
English	899	70.76%	68.19
French	28	2.18%	71.72
Other	200	17.71%	67.45
Registration Status			
Full-time	1007	89.35%	68.42
Part-time	120	10.64%	64.99
Citizenship			
Canada	1030	91.39%	68.21
India	18	1.59%	66.83
China	11	0.97%	75.24
Pakistan	7	0.62%	67.20
Lebanon	6	0.53%	68.97
Other	55	4.88%	67.04

Path Analysis



	Estimate(β)	Std.Err	z-value	p-value	Std.lv	Std.all
Regressions:						
On_Time ~						
Gender_Male	-0.048	0.006	-8.251	0.000	-0.048	-0.021
Gender_Female	0.070	0.003	21.806	0.000	0.070	0.055
Married	-0.005	0.003	-1.687	0.092	-0.005	-0.004
Single	-0.005	0.003	-1.687	0.092	-0.005	-0.004
young	0.049	0.003	15.527	0.000	0.049	0.050
midage	0.008	0.000	6.437	0.000	0.008	0.050
mature	0.001	0.000	8.720	0.000	0.001	0.034
X_Fathr_Schlng	-0.003	0.000	-8.886	0.000	-0.003	-0.024
X_Mothr_Schlng	0.002	0.000	6.437	0.000	0.002	0.018
Canada	-0.051	0.004	-13.209	0.000	-0.051	-0.047
India	0.109	0.006	16.977	0.000	0.109	0.051
China	-0.091	0.009	-10.199	0.000	-0.091	-0.028
Pakistan	0.155	0.011	13.999	0.000	0.155	0.037
Lebanon	-0.139	0.013	-10.575	0.000	-0.139	-0.028
othercities	0.003	0.000	11.994	0.000	0.008	0.050
Full-time	0.056	0.006	10.44	0.000	0.032	0.027
Part-time	0.032	0.003	10.547	0.000	0.032	0.027
English	0.047	0.004	11.479	0.000	0.047	0.064
French	-0.047	0.004	-11.479	0.000	-0.047	-0.029
Other	-0.037	0.004	-8.237	0.000	-0.037	-0.048
R-Square:						
On_Time	0.016					

1. **Std.Err:** Standard Error
2. **Std.lv:** Standard Lavaan
3. **Std.all:** Standard all the variables.

Male students emerged as a negative factor in predicting students' on-time degree completion variable ($\beta = -0.048$, $p = 0.000$) compared to female students ($\beta = 0.070$, $p = 0.000$). Students' marital status shows no impact on students' on-time completion ($\beta = -0.005$, $p = 0.092$).

In conclusion, marital status of the student doesn't show any effect on student's on-time degree completion. The greater estimate value of the youngest age bracket of students ($\beta = 0.049$, $p = 0.000$) shows that these students complete their degree on-time as compared to the middle age bracket ($\beta = 0.0080$, $p = 0.000$) and oldest group of students ($\beta = 0.001$, $p = 0.000$).

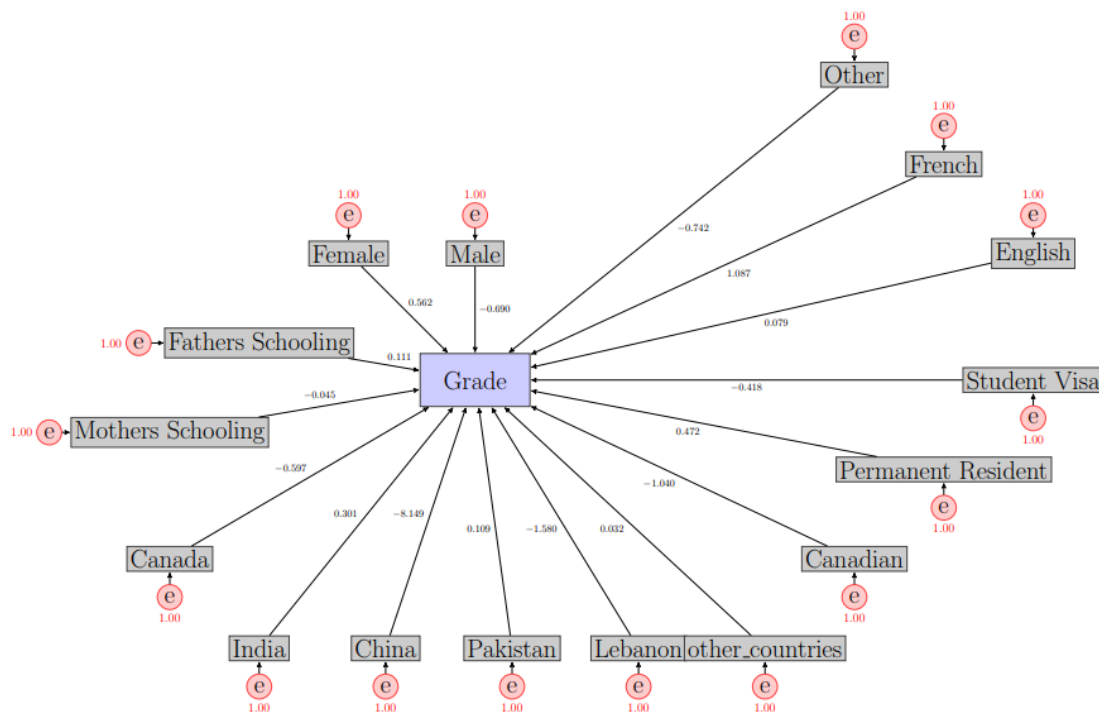
Hypothesis 3

In addition to the variables outlined in previous hypotheses, the variable of immigration status was added to hypothesis 3, which used path analysis to determine whether citizenship, immigration status, and first language influenced student grades.

Descriptive Statistics

Characteristics	Number of Students	Percentage	Term Grade (Mean)
Immigration Status			
Canadian Citizen	1030	91.39%	68.21
Permanent Resident	77	6.83%	69.05
Student Visa	20	1.77%	67.45

Path Analysis



	Estimate(β)	Std.Err	z-value	p-value	Std.lv	Std.all
Regressions:						
Grade ~						
Canada	-0.597	0.295	-2.024	0.043	-0.597	-0.011
India	0.301	0.311	0.970	0.332	0.301	0.003
China	-8.149	0.433	-18.840	0.000	-8.149	-0.052
Pakistan	0.109	0.535	0.204	0.838	0.109	0.001
Lebanon	-1.580	0.635	-2.486	0.013	-1.580	-0.007
othercities	0.032	0.016	1.948	0.051	0.032	0.005
X_Fathr_Schlng	0.111	0.015	7.301	0.000	0.111	0.020
X_Mothr_Schlng	-0.045	0.018	-2.488	0.013	-0.045	-0.007
English	0.079	0.096	0.822	0.411	0.079	0.002
French	1.087	0.206	5.273	0.000	1.087	0.011
Other	-0.742	0.099	-7.516	0.000	-0.742	-0.020
Canadian	-1.040	0.185	-5.622	0.000	-1.040	-0.020
Permannt_rsdnt	0.472	0.321	1.470	0.141	0.472	0.008
Student_visa	-0.418	0.291	-1.437	0.151	-0.418	-0.004
Gender_Male	-0.690	0.156	-4.432	0.000	-0.690	-0.011
Gender_Female	0.562	0.156	3.614	0.000	0.562	0.009
R-Square:						
Grade	0.003					

1. Std.Err: Standard Error
2. Std.lv: Standard Lavaan
3. Std.all: Standard all the variables.

Students who have permanent resident ($\beta = 0.472$, $p = 0.141$) as their immigration status tend to perform better compared to students with Canadian ($\beta = -1.040$, $p = 0.000$) and student visa ($\beta = -0.418$, $p = 0.151$). Students who have French as their native language ($\beta = 1.087$, $p = 0.000$) outperform the students with English ($\beta = 0.079$, $p = 0.411$) and other ($\beta = -0.742$, $p = 0.000$) as their native language.

The results from analyses on citizenship may be skewed because of the sample sizes. As seen above, 91% of the students report Canadian citizenship, and only 9% are from different countries. The results indicated that students from India ($\beta = 0.301$, $p = 0.332$), Pakistan ($\beta = 0.109$, $p = 0.838$) and other countries ($\beta = 0.032$, $p = 0.051$) had positive and significant effect on students' grades.

Hypothesis 4

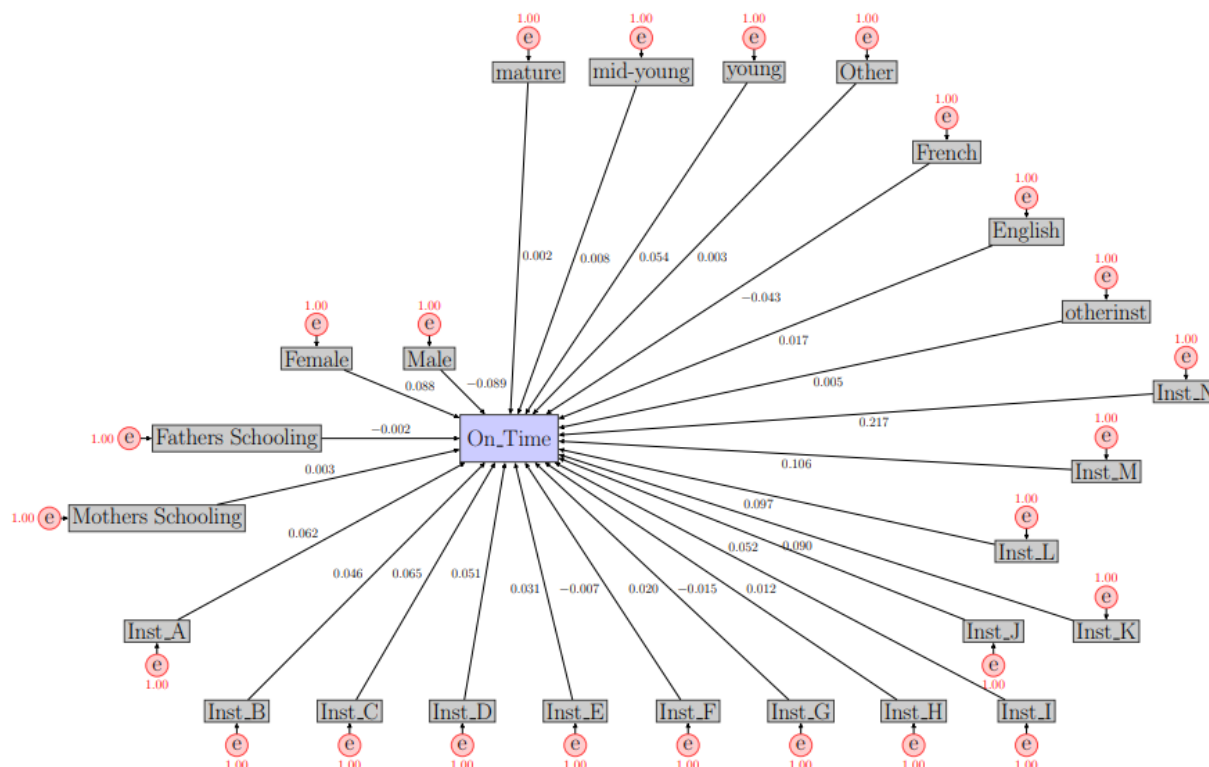
Hypothesis 4 combined the demographic variables described in previous hypotheses with the sending institution to determine whether the sending institution influences the student's on-time completion.

Descriptive Statistics

Characteristics	Number of Students	Percentage	Term Grade (Mean)
Sending institution			
Institution A	109	9.67%	63.77
Institution B	85	7.54%	68.12
Institution C	82	7.27%	69.30
Institution D	74	6.56%	67.21
Institution E	63	5.59%	67.85
Institution F	64	5.67%	68.19
Institution G	62	5.50%	68.48
Institution H	57	5.05%	72.28
Institution I	53	4.70%	71.17
Institution J	46	4.08%	69.83
Institution K	36	3.19%	66.01
Institution L	31	2.75%	66.19
Institution M	30	2.66%	66.19
Institution N	30	2.66%	68.82
Other institutions	308	27.32%	68.93

Sending institutions were included if the institution in the sample population had sent 30 or more students during the study period. Institution names were anonymized prior to analyses.

Path Analysis



	Estimate(β)	Std.Err	z-value	p-value	Std.lv	Std.all
Regressions:						
On_Time						
Inst_A	0.062	0.004	14.289	0.000	0.062	0.064
Inst_B	0.046	0.005	9.945	0.000	0.046	0.038
Inst_C	0.065	0.005	13.697	0.000	0.065	0.054
Inst_D	0.051	0.005	10.513	0.000	0.051	0.039
Inst_E	0.031	0.005	6.675	0.000	0.031	0.025
Inst_F	-0.007	0.005	-1.486	0.137	-0.007	-0.005
Inst_G	0.020	0.005	3.987	0.000	0.020	0.014
Inst_H	-0.015	0.005	-2.886	0.004	-0.015	-0.010
Inst_I	0.012	0.005	2.306	0.021	0.012	0.008
Inst_J	0.052	0.005	10.955	0.000	0.052	0.041
Inst_K	0.090	0.006	14.878	0.000	0.090	0.046
Inst_L	0.097	0.005	17.645	0.000	0.097	0.054
Inst_M	0.106	0.006	16.954	0.000	0.106	0.051
Inst_N	0.217	0.007	32.674	0.000	0.217	0.097
otherinst	0.005	0.000	22.319	0.000	0.005	0.123
Gender_Male	-0.089	0.003	-25.510	0.000	-0.089	-0.070
Gender_Female	0.088	0.003	27.275	0.000	-0.043	0.070
English	0.017	0.002	8.344	0.000	0.017	0.023
French	-0.043	0.004	-10.147	0.000	-0.043	-0.027
Other	0.003	0.002	1.320	0.187	0.003	0.004
X_Fathr_Schlng	-0.002	0.000	-6.720	0.000	-0.002	-0.019
X_Mothr_Schlng	0.003	0.000	8.703	0.000	0.003	0.024
young	0.054	0.003	17.245	0.000	0.054	0.056
midage	0.008	0.001	12.546	0.000	0.008	0.052
mature	0.002	0.000	10.409	0.000	0.002	0.041
R-Square:						
Completion	0.003					

1. **Std.Err:** Standard Error
2. **Std.lv:** Standard Lavaan
3. **Std.all:** Standard all the variables.

The students from sending institute N are significantly completing their degree on-time compared to the students from other institutions ($\beta = 0.217$, $p = 0.000$). Most other institutions are also positively related to on-time completion, with the exception of institutions F ($\beta = -0.007$, $p = 0.137$, not significant) and H ($\beta = -0.015$, $p = 0.004$). Students who have English as their native language tend to complete the university degree on-time ($\beta = 0.017$, $p = 0.000$) compared to students whose native language is Other ($\beta = 0.003$, $p = 0.187$). Students who have French as their first language shows a negative effect on on-time completion ($\beta = -0.043$, $p = 0.000$), which implies that they either take more time to complete or are not able to complete the degree.

Hypothesis 5

Hypothesis 5 combined the demographic variables described in previous hypotheses with the sending institution to determine whether the sending institution influences the student's academic performance.

Recognizing that the approach to grading students differs by sending institution, for example numerical vs. letter-based scales, sending and receiving grades were scaled for each institution on a 4-point scale, with 4 representing the highest grades at that institution.

Descriptive Statistics

Institution	Number of Students	Percentage	Previous Grade (M)	Current Grade (M)
A	126	10.007%	3.273	2.148
B	90	7.148%	3.273	2.148
C	104	8.260%	3.099	2.484
D	102	8.101%	3.217	2.521
E	73	5.708%	3.062	2.500
F	64	5.083%	3.074	2.531
G	77	6.116%	3.356	2.537
H	59	4.686%	3.459	2.836
I	55	4.368%	2.744	2.803
J	49	3.891%	3.469	2.587
K	40	3.177%	2.909	2.337
L	39	3.097%	3.357	2.485
M	31	2.462%	3.447	2.342
N	45	3.574%	3.283	2.427

Path Analysis

	Estimate(β)	Std.Err	z-value	p-value	Std.lv	Std.all
Regressions:						
Grade ~						
<i>Institute A:</i>						
Prevs_Inst_Grd	0.184	0.004	51.644	0.000	0.184	0.129
<i>Institute B:</i>						
Prevs_Inst_Grd	0.153	0.004	35.775	0.000	0.153	0.119
<i>Institute C:</i>						
Prevs_Inst_Grd	0.164	0.004	45.996	0.000	0.164	0.145
<i>Institute D:</i>						
Prevs_Inst_Grd	0.188	0.003	53.965	0.000	0.188	0.160
<i>Institute E:</i>						
Prevs_Inst_Grd	0.093	0.004	25.314	0.000	0.093	0.089
<i>Institute F:</i>						
Prevs_Inst_Grd	0.061	0.004	13.916	0.000	0.061	0.055
<i>Institute G:</i>						
Prevs_Inst_Grd	0.103	0.005	22.823	0.000	0.103	0.083
<i>Institute H:</i>						
Prevs_Inst_Grd	0.185	0.006	33.024	0.000	0.185	0.151
<i>Institute I:</i>						
Prevs_Inst_Grd	0.083	0.004	21.045	0.000	0.083	0.081
<i>Institute J:</i>						
Prevs_Inst_Grd	0.204	0.007	22.776	0.000	0.204	0.139
<i>Institute K:</i>						
Prevs_Inst_Grd	0.085	0.005	15.977	0.000	0.085	0.079
<i>Institute L:</i>						
Prevs_Inst_Grd	0.312	0.007	45.424	0.000	0.312	0.218
<i>Institute M:</i>						
Prevs_Inst_Grd	0.195	0.007	26.349	0.000	0.195	0.134
<i>Institute N:</i>						
Prevs_Inst_Grd	0.196	0.007	28.972	0.000	0.196	0.145

1. Std.Err: Standard Error
2. Std.lv: Standard Lavaan
3. Std.all: Standard all the variables.

A student's previous grades were shown to have a positive influence on their current grades from all institutions ($p = 0.000$). The β estimates are highest for institutions L and J, suggesting positive effect of previous grades on current grades is highest in students from these institutions. The β estimates are lowest for institutions F and K, suggesting positive effect of previous grades on current grades is lowest in students from these institutions.

Hypothesis 6

Hypothesis 6 combined the demographic variables and the sending institution described in previous hypotheses with the number of required transition courses to determine whether the number of transition courses influences the student's academic performance.

Descriptive Statistics

Characteristics	Number of Students	Percentage	Term Grade (Mean)
Spring entry			
5 courses	331	29.06%	66.98
6 courses	225	19.75%	69.48
7 courses	264	23.17%	70.18
8 courses	219	19.22%	68.64
9 courses	76	6.67%	65.57
10+ courses	17	1.49%	69.10
Fall entry			
5 courses	3	3.51%	70.00
7 courses	15	17.85%	66.65
8 courses	13	15.17%	67.68
9 courses	23	27.38%	66.78
10+ courses	29	34.52%	70.18

Path Analysis

Spring entry

	Estimate(β)	Std.Err	z-value	p-value	Std.lv	Std.all
Regressions:						
Grade						
Five	3.384	0.033	103.333	0.000	3.384	0.082
Six	-0.607	0.037	-16.523	0.000	-0.607	-0.013
Seven	-1.973	0.035	-56.732	0.000	-1.973	-0.045
Eight	-1.856	0.039	-47.674	0.000	-1.856	-0.038
Nine	1.275	0.062	20.681	0.000	1.275	0.017
Ten	-0.720	0.031	-23.219	0.000	-0.720	-0.019
Gender	0.967	0.060	16.159	0.000	0.967	0.013
Age_First_Term	0.048	0.005	10.577	0.000	0.048	0.008
R-Square:						
Grade	0.009					

1. **Std.Err:** Standard Error
2. **Std.lv:** Standard Lavaan
3. **Std.all:** Standard all the variables.

Analyses were done for students who enter in the spring and fall terms separately, as those who enter in the spring are typically assigned an overall lower number of transfer required courses, and the types of courses are typically different. In the above table for spring entry students, the Project Team found that having five or nine assigned transition required courses positively influenced academic performance, while having any other number of transition required courses negatively influenced academic performance.

In the table below, depicting fall entry students, only having ten or more transition required courses negatively influenced academic performance. All other transition required course groupings saw a positive effect in academic performance.

Fall entry

	Estimate(β)	Std.Err	z-value	p-value	Std.lv	Std.all
Regressions:						
Grade [~]						
Five	2.636	0.242	10.908	0.000	2.636	0.031
Seven	3.388	0.126	26.866	0.000	3.388	0.080
Eight	0.989	0.133	7.418	0.000	0.989	0.021
Nine	0.477	0.116	4.105	0.000	0.477	-0.091
Ten	-0.872	0.027	-32.639	0.000	-0.872	-0.111
Gender	-6.049	0.259	-23.388	0.000	-6.049	-0.068
Age_First_Term	-0.114	0.016	-6.973	0.000	-0.114	-0.021
R-Square:						
Grade	0.016					

1. **Std.Err:** Standard Error
2. **Std.lv:** Standard Lavaan
3. **Std.all:** Standard all the variables.

Predictive model using machine learning algorithms

Based on the findings of the SEM, the Project Team developed a predictive model using machine learning algorithms.

The predictive model was developed based on the complete dataset, for entering cohorts from 2004 through to 2016.

The model allows a user to input options based on the variables in the database and then offers a prediction for completion based on the user entered variables.

Home Prediction Model Judgements SOM

Lakehead UNIVERSITY Student Success Model DATA Lab

Aboriginal Declaration	Not Given/Other
Aboriginal Declaration Type	Not Given/Other
Citizenship	Not Given/Other
Father Schooling	Not Given/Other
Mother Schooling	Not Given/Other
Marital Status	Not Given/Other

Results

Predicted scores

Submit judgement

Profile Judgement	
Comment	
<input type="button" value="Submit"/>	

Disclaimer: The application is in its beta version, and we will continue improving the model for better accuracy. Project funded by ONCAT

The above figure demonstrates the predictive model using machine learning algorithms. This model is currently being tested by the Faculty of Engineering, with the expectation that it will continue to be tested and refined over the coming months, and will inform longer term studies on the accuracy of predictions of success in the Program based on actual student outcomes.

Future Directions

Our study presents a number of exciting opportunities for future research on variables related to transfer student success at Lakehead University.

First, through the environmental scan, a number of avenues for collection of variables of interest were presented. Variables available through survey measures might lend themselves to development of proxy measures, as we used postal codes as a proxy for socio-economic status in this study. Using the currently available survey data relating to graduate outcomes and satisfaction measures and applying inferential techniques to fill in gaps might make sense with a larger data set.

Second, this study led the Project Team to conclude that it is crucial to develop an understanding of the transfer program you are working with. Transfer programs, even those that are long established such as the one studied here, have their own program requirements that often do not fit a prescribed mold. We found that the courses assigned to transfer students, specifically in their first year of study at Lakehead, were largely personalized to the student based on a number of variables including sending institution, first diploma/degree program/field of study, and a series of other variables that continue to be refined within the Faculty of Engineering at Lakehead University. Understanding a transfer program's intricacies and historical evolution is therefore crucial for properly interpreting data about its students.

Third, throughout the data collection process, unique challenges were identified with transfer student data, including completeness of records, evolving approaches to data collection and, in some cases, opportunities to collect a more comprehensive data set to inform future longitudinal analyses. Developing a method to quickly extract data from the SPEEDE transcripts, something that was developed specifically for this study, presents very exciting future potential applications. Pursuing a longer term solution to extracting data from SPEEDE transcripts mitigates the time consuming need to combine data from different sources, which may include paper and electronic transcripts and can help to bridge data consistency and completeness gaps, but also can present practical challenges.

Further, developing a level of consistency in the sending institutions' transcripts would also assist in comparability of marks across institutions, and would be especially helpful in analyzing transcripts from sending institutions that may have changed their marking system part way through a student's study period. The current practice, in which institutions use different marking scales makes comparing students from different institutions a time consuming task that requires care and attention to understanding just how each individual institution presents data on their students, and how the receiving method, whether electronic or paper, compares to other sources. Implementing consistency in this area would support the ability to develop a more personalized experience tailored to the student's needs through the use of predictive models.

Finally, this study looked at a very specific transfer program at Lakehead University with a very specific student population. While the number of sending institutions is fairly large, and there are a number of receiving engineering streams available, findings show our sample is largely comprised of Canadian males between the ages of 21 and 25 whose first language is English. Therefore, while this study produced many interesting findings that are currently being shared with the Faculty of Engineering at Lakehead University, broader application of the findings of this study to other populations of transfer students would be inappropriate. However, the methods applied throughout this analysis do present an opportunity in expanding this study to other transfer student populations.

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