University Acceptance of High School Mathematics in Alberta

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The transition between secondary and postsecondary mathematics is a complex process which involves an array of problems and issues that students have to overcome. Some of the issues that students experience transitioning to postsecondary mathematics include "type of mathematics taught, conceptual understanding, procedural knowledge required to advance through material, and changes in the amount of advanced mathematical thinking needed" (Hong et al 2009, 878). Hong goes on to say that research on this topic indicates that the mathematical under-preparedness of students entering university is an issue. Additionally, Kajander and Lovric (2005) stated that "there is evidence of similar gaps in other disciplines in science and beyond, it seems that the transition in mathematics is by far the most serious and most problematic" (p 149). With this in mind, understanding the relationship between secondary mathematics and university mathematics is key to ensure the smoothest possible transition for students.

In addition, completion of algebra-intensive high school mathematics courses has been shown to improve the likelihood of students later completing a bachelor's degree at postsecondary. Adelman (1999), through the U S Department of Education, used data from a national longitudinal study that spanned from 1980 to 1993 to illustrate that of all the courses within the high school curricula, finishing high school mathematics courses had the strongest effect on future bachelor's degree completion. Trusty (2003) performed a similar study with 5,257 participants taken from the National Education Longitudinal Study finding that the greater number of math courses (trigonometry, pre-calculus, calculus and algebra 2) a student took, the greater the likelihood of that student completing a bachelor's degree. Furthermore, finishing even one algebraic math course more than doubled the likelihood of a student completing a future degree. The studies from Adelman and Trusty clearly illustrate that providing students with opportunities to take algebraic math classes will benefit them in future degree completion; thus, ensuring that students have the appropriate experiences with mathematics in high school is important to consider.

With both the transition experience of students and the content of high school mathematics courses impacting student degree completion in mind, we investigated the Alberta high school mathematics program of studies and its acceptance at certain universities in Alberta. Our main goal was to illustrate which high school mathematics courses in Alberta are being accepted at which universities in Alberta for which programs. With new curriculum currently being developed, it would be important for both secondary and postsecondary education to collaborate and maintain educational pathways full of options that do not limit student potential to be successful in postsecondary. Within the new curriculum, ensuring that students are able to access multiple pathways to get experience with algebraic mathematics would be beneficial for all students.

In 2010, Alberta's high school mathematics program was in the process of changing. New Grade 10 courses were being implemented in 2010 with Grade 11 following in 2011 and Grade 12 in 2012. The mathematics program that was introduced in 2010 was developed as part of the Western and North Canadian Protocol (WNCP) which included four provinces (Alberta, British Columbia, Manitoba and Saskatchewan) and three territories (Nunavut, Northwest Territories and Yukon). The WNCP's vision was to provide high-quality K–12 education for all students (System Improvement Group 2006). Specifically, the mathematics program was designed to provide students with the mathematical skills and competencies necessary to make a smooth transition from secondary mathematics studies to postsecondary programs and the world of work.

These new courses and course sequences replaced the Mathematics Pure and Applied course sequences that had been in place since 2000 (Alberta Learning

2002 a, b). One of the critiques of the Applied course sequence was that it was universally not accepted as a gateway to university entrance due to its lack of algebraic focus (System Improvement Group 2006). Students who were interested in pursuing bachelor's degrees were required to take Pure Mathematics 30, thus relegating the Applied course sequence to those who were seen as not going into university studies. The System Improvement Group report (2006) suggested three high school pathways that should satisfy stated admission requirements for the appropriate postsecondary programs or workforce requirements as follows:

1. Ensure that Pathway 1 satisfies the entrance requirements of the calculus-based (and similar) post-secondary programs with the fewest possible outcomes.
2. Ensure that Pathway 2 satisfies the entrance requirements of most of the remainder of the non-calculus-based programs.
3. Ensure that Pathway 3 satisfies the entrance requirements of the trades and agriculture, and with a few additions, meets the needs of business and industry for positions for which they recruit from high schools. (p 57)

While the other WNCP provinces accepted the three pathways as articulated above, Alberta altered the content of Pathway 2 in order to satisfy additional algebraic requirements as articulated by Alberta's postsecondary institutions to ensure acceptance of Pathway 2 for university entrance. As the focus of this paper is illustrating the Alberta university acceptance of mathematics courses in Alberta, we will focus on the first two pathways.

The course descriptions from the Alberta Program of Studies for the "-1" and "-2" course sequences that were introduced in 2010 are as follows:

> "-1" Course Sequence: This course sequence is designed to provide students with the mathematical understandings and critical-thinking skills identified for entry into postsecondary programs that require the study of calculus. Topics include algebra and number; measurement; relations and functions; trigonometry; and permutations, combinations and binomial theorem. (Alberta Education 2008, 10)
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> "-2" Course Sequence: This course sequence is designed to provide students with the mathematical understandings and critical-thinking skills identified for post-secondary studies in programs that do not require the study of calculus. Topics include geometry, measurement, number and logic, logical reasoning, relations and functions, statistics, and probability. (Alberta Education, 2008, 10)

Both the "-1" and "-2" sequence descriptions advocate for entry into postsecondary programs. The "-1" is for programs that entail calculus, and the "-2" for studies that do not require calculus. Even though the high school mathematics course sequences had changed to better align with university expectations, teachers were unsure if universities would accept the "-2" sequence as an entrance requirement for those programs that do not require calculus. This paper illustrates the acceptance of the "-1" and "-2" sequences at five universities in Alberta in order to highlight potential opportunities for students based on secondary mathematics courses.

To illustrate the current acceptance of Alberta high school mathematics courses, we investigated the entrance requirements of five Alberta universities: Mount Royal University, MacEwan University, the University of Calgary, the University of Alberta and the University of Lethbridge. These universities were chosen as they represent five of the six largest universities in Alberta. The data sources included the university's websites, course outlines and academic calendars from summer 2016. We obtained entrance requirements for all programs at the institution as well as the listed prerequisites for entry level mathematics courses. In our investigation we also included which university programs and individual mathematics courses listed Math 31 as a prerequisite. Math 31 is the high school level calculus course in Alberta that did not go through a redesign with the WNCP course development thus it has been unchanged in Alberta since its introduction in 1995 (Alberta Education 1995).

In Figure 1, the faculties and programs that require mathematics in order for students to be accepted are illustrated. Only programs that require mathematics as a prerequisite were listed along with the specific course that was identified as the prerequisite. If a program is not listed, it did not state a high school mathematics course as a prerequisite.

At the University of Lethbridge, there are 12 programs in the Faculty of Arts and Science and the Faculty of Management that require Math 30-1 for admission. Of these programs, five of them do not need calculus to progress through the degree. With

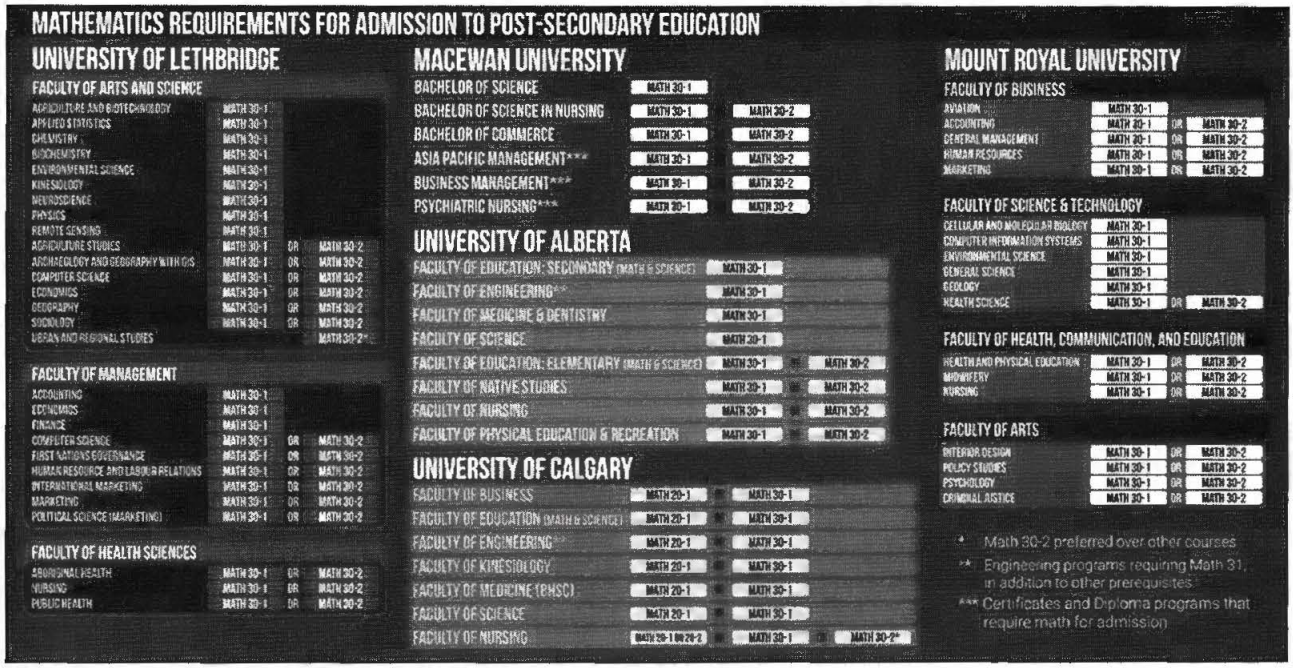

Figure 1. *Illustration of the mathematics requirements for entrance to specific programs at five universities in Alberta (Marynowski and Forand 2016).*

respect to the University of Calgary, the Faculty of Nursing is the only faculty that not only accepts Math 30-2 but also gives preference to Math 30-2 over the other mathematics courses. Of all the faculties at the University of Alberta, four of them accept Math 30-2 as a prerequisite.

In addition to mapping out specific program mathematics requirements, the prerequisites for individual first-year university mathematics courses were identified. Figure 2 illustrates how many first-year university mathematics courses require which high school math course as a prerequisite. The intent of the mapping was to visually display the predominant acceptance of Math 30-1 as a prerequisite for university mathematics courses and to illustrate that Math 30-2 sequence is also accepted as a university mathematics course prerequisite, only on a smaller scale. Only the university mathematics courses that required a high school mathematics course as a prerequisite were included in the graph.

A total of 40 first-year mathematics courses are offered by the five universities shown above. Of those courses, Math 30-1 is indicated as a prerequisite for every introductory university mathematics course. Math 30-2 is accepted as a prerequisite for 11 of the 40 courses while Math 31 (calculus) is a prerequisite for 8 courses. Of the 40 university mathematics courses, only 15 of them are identified as calculus courses, implying that Math 30-2 could lead to 25 university courses based on the Alberta Education description for the "-2" sequence. The acceptance of the Math 30-2 course as a university prerequisite is

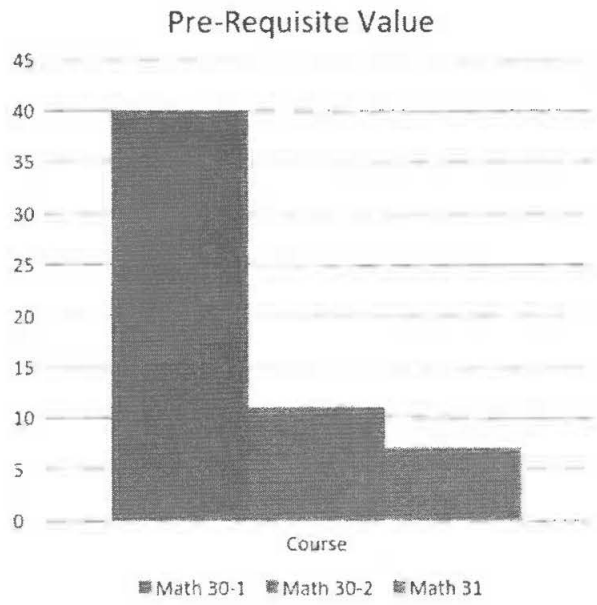

Figure 2. *First-year university mathematics course prerequisites.*

a positive development from the Applied Mathematics sequence that existed prior to 2010.

The intent of the current math curriculum in Alberta was to make both Math 30-1 and Math 30-2 acceptable prerequisites in Alberta. As shown above, the "-1" sequence is much more prominent and does not limit the student's choice when looking into postsecondary options. Math 30-1, in comparison to the previous mathematics course Pure Mathematics 30, has fewer outcomes and concentrates on the preparation of students to be successful in calculus. Content like statistics and probability are no longer included in the "-1" sequence with the focus of the course sequence being algebraic manipulations and algebraic representations of functions in preparation for students to study calculus. Math 30-2 in the meantime includes statistics, logical reasoning and set theory which are content that is applicable for noncalculus courses.

According to Alberta Education (2008, 10), "each course sequence is designed to provide students with the mathematical understandings, rigour and critical-thinking skills that have been identified for specific postsecondary programs of study." The intention for the "-2" course sequence was not to be easier than "-1" but to provide opportunities to engage with different content. Ideally, students choose which mathematics course sequence to take depending on the topics covered and postsecondary aspirations (Alberta Education 2008) rather than on the difficulty of the course. However, the legacy that Applied Mathematics left in Alberta as a course that was perceived by teachers and students to be less rigourous than Pure Mathematics might be impacting the implementation of the intended rigour of the "-2" sequence.

Despite both the "-1" and "-2" sequences being designed for students entering postsecondary, Math 30-2 is not accepted as widely as it might be. However, knowing specifically why the "-2" course is not accepted for noncalculus courses at these five universities in Alberta cannot be determined from this data. Further exploration is needed to identify what, if anything, is prohibiting the "-2" course sequence from being more widely accepted and to gather information from colleges and technical institutes in Alberta with respect to what secondary mathematics courses serve as prerequisites for their programs and courses. The intent of this article was primarily to highlight improvements in the acceptance of the "-2" sequence over the Applied sequence and secondarily to inform secondary educators as to the university programs that accept the existing mathematics courses so that they can inform their students of the options available to them.

References

Adelman, C. 1999. *Answers in the Tool Box: Academic Intensity, Attendance Patterns, and Bachelor's Degree Attainment.* Washington, DC: National Institute on Postsecondary Education, Libraries, and Lifelong Learning (ED/OERI).

Alberta Education. 1995. *Mathematics 31.* Edmonton, Alta: Alberta Education.

———. 2008. *Mathematics 10–12 Program of Studies.* Edmonton, Alta: Alberta Education.

Alberta Learning. 2002a. *Applied Mathematics 10-20-30.* Edmonton, Alta: Alberta Learning.

———. 2002b. *Pure Mathematics 10-20-30.* Edmonton, Alta: Alberta Learning.

Hold Fast Consultants. 2004. *WNCP Mathematics Research Project: Final Report.* Prepared for Western and Northern Canadian Protocol. Victoria, BC: Hold Fast Consultants.

Hong, Y Y, S Kerr, S Klymchuk, J McHardy, P Murphy, S Spencer and M O J Thomas and P Watson. 2009. "A Comparison of Teacher and Lecturer Perspectives on the Transition from Secondary to Tertiary Mathematics Education." *International Journal of Mathematical Education in Science and Technology* 40, no 7: 877–89.

Kajander, A, and M Lovric. 2005. "Transition from Secondary to Tertiary Mathematics: McMaster University Experience." *International Journal of Mathematical Education in Science and Technology* 36, nos 2–3: 149–60.

Kremers, A L. 2010. *The Effect of Advanced Placement and Concurrent Enrollment on Postsecondary Math Achievement.* Master's thesis, University of Arkansas at Little Rock.

Marynowski, R, and L Forand. 2016. "A Preliminary Analysis of Mathematics Requirements in Alberta Universities." Poster presented at the annual meeting of the Canadian Mathematics Educators Study Group, Kingston, Ont.

System Improvement Group. 2006. *Western and Northern Canadian Protocol (WNCP) Consultation with Postsecondary Institutions, Business and Industry Regarding Their Requirements for High School Mathematics: Final Report on Findings.* Edmonton, Alta: Alberta Education.

Trusty, J. 2003. "High School Math Courses and Completion of the Bachelor's Degree." *Professional School Counseling* 7, no 2: 99–107.

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