MATHEMATICS REVIEW

Report to Premier and Minister

December 2016

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Introduction

All students in Alberta should have the opportunity to succeed and be empowered to pursue the career of their choice. As Alberta diversifies its economy and job opportunities become more varied, having a strong background in mathematics is becoming increasingly necessary. Also, learners no longer need to focus on a singular body of knowledge; they need to be confident in their abilities when encountering new situations and be innovative and creative problem solvers.

Currently, approximately 60% of students enter a post-secondary program (including trade programs) within 6 years of entering high school *(Source: Alberta Education (2016) Accountability Pillar Results for Annual Education Results Report)*. Approximately half of those post-secondary programs have a mathematics course as a completion requirement for graduation *(Source: Alberta Education (2016) Review of Post-Secondary Entrance Data and Program Course Requirements).* It was with this in mind that the Government of Alberta sought to have a focused look at some of the experiences post-secondary instructors have with students taking post-secondary studies requiring mathematics or a mathematics-related course. With the increasing number of Science, Technology, Engineering and Mathematics (STEM) careers and growing public interest and discourse about how students in Alberta are faring in mathematics, it is an important perspective to consider.

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Background

In May 2016, a committee – the Mathematics Curriculum Review Working Group –was created to provide advice about experiences with graduates of Alberta's primary and secondary mathematics program entering post-secondary mathematics studies. This committee consisted of six members; five post-secondary mathematics instructors and one high school physics teacher. The working group was provided with some initial questions to consider regarding current and potential future post-secondary math requirements and preparedness of Alberta students entering post-secondary math courses (Appendix 1). Members of this working group were invited to participate in this overview of the current mathematics program on the basis of their relevant backgrounds, and they were asked to provide their unique perspectives based on their experiences teaching students in mathematics or mathematics-related courses.

The group met virtually and in person from May 2016 to October 2016 and submitted their final report to the Minister of Education and the Premier on October 31, 2016.

While the Working Group members had their own experiences in teaching graduates of Alberta's mathematics program to inform their advice, their collective response was not limited to their own anecdotal evidence; it was gleaned from a variety of sources including assessment data, post-secondary program course requirements and the reflections of others involved in the world of mathematics. Specifically:

International, national and provincial assessment data was examined (Appendix 2) to identify trends in the achievement of Alberta students. Additionally, the transition rate from high school to post-secondary was provided (Appendix 3) along with information pertaining to the pre-requisite mathematics requirements in Alberta's post-secondary programs along with the mathematics courses required within these post-secondary programs (Appendices 4 and 5). *See Bibliography for listing of resources consulted.*

The Working Group also received input from seven advisory panels consisting of a variety of stakeholders in mathematics education. Their responses to specific questions also contributed to the findings and recommendations of the Working Group (Appendix 6).

Alberta Education is beginning a six-year K–12 curriculum renewal process across 6 subjects, including Mathematics. Expert Working Groups have been formed for the development of future curriculum consisting of teachers, post-secondary professors, post-secondary instructors and Alberta Education curriculum developers. A variety of stakeholder perspectives will be considered in addition to research, assessment results analysis, program reviews, etc. This report from the Mathematics Working Group will be primarily considered in that context.

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Findings

The scope of the committee's work was to provide insight into the transition from K–12 mathematics to post-secondary mathematics courses from their perspective.

The Working Group's insight was to be informed by answers to the specific questions contained in Appendix 1, as well as the examination of the data and advisory panel summaries. It is important to note that despite numerous attempts, the working group was not able to collect data to support the request for non-anecdotal post-secondary evidence regarding preparedness of students entering post-secondary math courses. Post-secondary institutions currently do not collect or track this information.

The Working Group, through their experience in teaching under-graduate mathematics students, shared personal observations about finding students stressed about mathematics related requirements to the point where it sometimes caused delays to their post-secondary progress or a re-evaluation of their post-secondary path. Some patterns that emerged from these discussions and the consultations with advisory panels are:

1. The lack of some foundational mathematics skills was identified as one of the major issues for students entering post-secondary studies. Examples of areas of concern noted by the group are basic algebra skills, (in particular working with fractions and exponents), order of operations, distinguishing between linear and non-linear functions, and trigonometry. As a member of the post-secondary mathematics-heavy advisory panel noted, "Algebra is the big concern, even solving for a single unknown." Algebra is the language of Mathematics and any student who does not have a good grasp of this language is likely to struggle in post-secondary Mathematics courses. The ability to manipulate fractions was also identified by members of the Working Group as being a deficit for some students. An inability to determine common denominators was often cited as one of the greatest contributors to misunderstanding the algebra of rational expressions (i.e. fractions).

It is clear that many students do not really understand trigonometric functions. Rational and Trigonometric expressions arise routinely and regularly in Calculus courses in particular and students in these courses with the aforementioned deficits are at a serious disadvantage.

2. An over-reliance on calculators is a contributor to the lack of some fundamental Mathematics skills, such as recognizing and executing the correct order for a sequence of operations. Because students tend not to regularly practice these skills in isolation, they tend to rely on their calculator for the answer in many cases. There is a disconnect for students who have been allowed to use calculators in their junior high and high school mathematics classes, to be suddenly faced with post-secondary classes where the use of a calculator is banned. An interesting by-product of calculator overuse was mentioned by several advisory panel members: students are not confident in their own mathematical ability. “Use of calculators can decrease confidence in the head of the student.”

3. The working group and the advisory panels also identified other themes contributing to student achievement in mathematics.

- The importance of students having a positive attitude toward mathematics. The development of perseverance, confidence and the ability to learn from mistakes are goals we should strive for. As one panel member reported, “If we want students to be comfortable with messiness, then we have to assess with messiness as well. Multiple choice doesn’t allow for this.”

- There was strong support for the inclusion of a requirement for students in the K–12 system to show their work. The Working Group and the advisory panels both stressed the importance of communication in mathematics and of the process of learning and understanding mathematics. Multiple-choice questions (which are prevalent on the high school mathematics diploma exam) are not, by themselves, the most effective tool for assessing problem solving and communication skills.

- Communication, developing a deep understanding of different mathematical concepts and realizing the connections between them as well as with other subjects, were all seen as critical to the development of mathematical thinkers. It was acknowledged that these were areas in which many teachers needed more support, either through professional learning opportunities, collegial support, or resources for use in classrooms. The curriculum should be reviewed to allow for more connectivity between topics.

- Clarifications were issued by Alberta Education in 2014 to K–6 teachers stating that they should allow students to solve questions by any suitable method and they were found to be very helpful. In September 2016, clarifications were extended to grades 7-9 which should also prove to be helpful: students should not be required to use a specific method for solving a problem; instead they should be asked to solve by any method that works and can be properly justified.

- There is a very steep learning curve in the high school grades and students struggle to grasp and absorb many challenging new concepts in a relatively short time. Some of these concepts should be introduced earlier and spread over a greater number of years to give students time to thoroughly grasp them.

These findings, from the expertise and experiences of the Working Group, examination of assessment and post-secondary program data, as well as the consultations with advisory panels led to the following proposed shifts and recommended actions:

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Shifts

Based on an analysis of their findings including their own experiences, data collected, and input from advisory panels, the Working Group suggests the following shifts in the K–12 approach to mathematics in Alberta to better enable student success in post-secondary mathematics:

SHIFT	FROM	TO
1	Individual teachers responsible for professional development	System support for teachers
2	Focus on literacy in schools	Focus on literacy and numeracy*
3	Emphasis on the answer	Emphasis on the process
4	Doing mathematics as required	Valuing exploration, curiosity and creativity
5	Separate disconnected mathematics units	Cohesive, continuous, cumulative application of skills and knowledge
6	Steep learning curve into and from year to year in high school	Earlier introduction of fundamental concepts with more gradual ramp up of learning

** Mathematics and numeracy both draw on the same body of mathematical knowledge but they are not the same. School mathematics is subject-specific and begins with the study of numbers, patterns, shape, space, statistics and probability and becomes increasingly abstract as students move up in grades. Numeracy is having mathematical understandings and knowing when and how to apply them in various subjects and in everyday situations.*

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Recommendations

The Mathematics Curriculum Review Working Group recommends the following actions in support of the above shifts:

1. An increased availability and access to high-quality professional development and training opportunities specific to the teaching of Mathematics.

- Ideally, all teachers of junior high and high school mathematics should be mathematics majors or minors. However, recognizing that this is not currently possible, resources should be in place to support teachers who do not have this qualification. Training opportunities specific to the teaching of Mathematics would help teachers to make connections between topics, to recognize the mathematics concepts involved in various problems and to recognize when a student who uses a different approach to the teacher is still correct.

- A designated mathematics specialist should be available in all K–6 schools to assist teachers who are generalists. Typically, Alberta's elementary teachers take very few mathematics courses and are more likely to be focused on literacy than numeracy. In order to be certificated in Alberta, an elementary teacher is required to have three credits in mathematics, which does not have to include an instructional methods course. This differs from Quebec where elementary teachers are required to take a minimum of nine credits in mathematics, but most take between 12 and 15 credits. These credits equate to credits at Alberta institutions.

- Professional development and supports should be provided that focus on helping teachers make the front matter of the current K–12 curriculum come alive in their classrooms. Additionally, teachers should be provided with a scope and sequence that specifically highlights the connections between units, topics and grades.

2. A shift in the culture of mathematics in school, including placing a focus on numeracy in schools at all grade levels.

- Numeracy should be considered an essential component in all subjects.
- Emphasis should shift from the final answer to the process. This would likely lead to a more language rich mathematics class which would benefit all learners and in particular the English language learners.
- Students must understand that mathematics takes practice. They should not be afraid to make mistakes.
- Students need to develop perseverance and confidence in their mathematics ability.

3. Alberta Education re-instate a written portion to the Mathematics 30-1 and Mathematics 30-2 diploma exams. The anticipated benefits of such a move are:

- an improved understanding by students. A written response question requires a student to think clearly about a solution and to present it in the form of a logical, coherent argument.
- a more accurate measure of students' level of understanding. A correct answer on a multiple-choice question could be the result of a lucky guess or simply trying all available answers to see which one is right. Conversely, a wrong answer may be caused by a minor miscalculation or a clerical or typographical error rather than a lack of understanding.
- an increase in written responses in the classroom. This would likely result from a change in format on the diploma as classroom assessments tend to mirror the format of the exams.
- teacher-scored exams, as marking allows for excellent professional development opportunities for teachers. Many missed this opportunity when the written response was removed from the exams in 2010.

4. That the use of calculators is thoughtful, age appropriate, and balanced with demonstrations of understanding without the aid of technology. This includes that:

- the use of calculators for number operations should not be introduced until students have developed understanding of the concepts (with certain exceptions at the teacher's discretion, for example students with learning disabilities or cognitive delays). Calculator use should be limited in the elementary grades.

- where occurring, a shift from the exclusive use of graphing calculators to a balance of sketching by hand and using other graphing applications. For example, students should be able to sketch the graphs of linear, quadratic and trigonometric functions by hand and to interpret the graphs.

- the inclusion of other assistive technologies as appropriate; for example, inclusion of Excel.

- Alberta Education should consider conducting part of the diploma exams without a calculator.

5. That Alberta Education consider integrating the subject's introduction section of future curriculum with the learning outcomes (what students are expected to know, understand and be able to do); and consider the following changes to future curriculum content:

- the earlier teaching of the arithmetic of fractions without the use of a calculator (unless a special accommodation is required by the student). Mastery of basic fractional arithmetic is essential when dealing with rational expressions in high school Mathematics courses.

- an acceleration of the treatment of linear relations (currently done in grades 7, 8 and 9) and placing greater emphasis on solving related problems by algebraic methods.

- the earlier introduction of non-linear relations – in particular, trigonometric, exponential and logarithmic functions should be introduced sooner to allow the study of these concepts in greater depth and in various contexts.

- a greater emphasis on spatial reasoning in elementary and secondary mathematics.

- clear communication between Alberta Education and post-secondary regarding future high school curriculum content changes.

6. That Advanced Education undertakes a focused research initiative to inform a long-term study on how to monitor readiness and success in post-secondary mathematics programs.

APPENDICES

1. Questions
2. Standardized Assessment Test Results
3. Post-Secondary Entrance Data and Program Course Requirements
4. Post-secondary Programs Mathematics Pre-requisites
5. Post-secondary Programs with Mathematics or Mathematics Related Courses within the Program
6. Advisory Panel Themes
7. Math Curriculum Review Working Group

Appendix 1:

Questions

1. **Which current university, college, NAIT and SAIT, and other vocational programs have a mandatory mathematics co-requirement in calculus, statistics, and other?**

   The answer to this sub-question is contained in Appendices 4 and 5 where the pre-requisite mathematics requirements for all Alberta post-secondary programs were examined as well as the mathematics or mathematics related courses contained within each post-secondary program. As expected, the mathematics requirements vary greatly by program depending on the focus. Science related programs have more mathematics requirements than Arts related programs.

2. **Are more such programs with mandatory mathematics likely to emerge?**

   The answer to this question is speculative. We are unaware of any new programs to date that are now requiring a mathematics course – it would be unlikely that an area of study that previously did not need mathematics would suddenly decide to require it. However, as different specialties in certain areas emerge (i.e. new engineering specialties, new IT specialties) – if those areas currently require mathematics, it is expected that the mathematics requirement would continue in the new specialties.

   With the increase in Science, Technology, Engineering and Mathematics (STEM) careers, it is likely that mathematics will be a requirement for more STEM related post-secondary programs and that more students will be entering these programs.

   As part of Alberta Education's needs assessment for future mathematics programs, they are asking about new topics that should be included such as coding, financial mathematics and an increased focus on geometry.

3. **Is there non-anecdotal evidence that graduates from the Alberta K–12 public system are entering such programs with deficits in their mathematics background that may impede their success in the mandatory mathematics aspects?**

   It is difficult to obtain non-anecdotal evidence as post-secondary institutions typically do not gather data that would specifically address this question. One university provided data from a gateway exam for entry to Introductory Calculus and from a Mathematics advisory exam administered to incoming Engineering students. Both exams are based on topics covered in high school Mathematics courses. The failure rate on the gateway exam since fall 2014 is about 75%. Average scores on the advisory exam have typically been in the 51-56% range since 2000. The high failure rate on the gateway exam, and the relatively low scores on the advisory exam over the past 16 years, suggest that the articulation between secondary and post-secondary mathematics should be further examined.

4. **What are historical and inter-jurisdictional comparisons on:**

   - withdrawals from programs with mandatory mathematics?
   - portion of over-all post-sec enrolment in programs with mandatory mathematics?
   - failing grades in first year mathematics courses or pre-assessment exams?
   - repeated taking of mandatory courses to improve grades?
   - mathematics GPAs?
   - standardized assessment test results?

   The data for bullets 1, 3, 4 and 5 are not formally collected by the post-secondary institutions. The information for bullet 2 is contained in Appendices 4 and 5. The data for bullet 6 is contained in Appendix 2.

5. **Is there non-anecdotal evidence of specifically what knowledge, skills or understanding is most lacking in new post-secondary entrants from Alberta Grade 12?**

   As noted in the response to question 3, post-secondary institutions do not typically gather data that would address this question. On the Mathematics advisory exam for new Engineering students that was referred to earlier, the questions with the lowest success rate were on Trigonometry.

6. **What is the anecdotal or experiential evidence of any shortcomings?**

   Many post-secondary mathematics instructors report that students struggle with basic Algebra and Trigonometry. In particular they often do not perform the correct order of operations when dealing with algebraic expressions. These basic skills are crucial in post-secondary mathematics courses and it is very difficult for a student with such shortcomings to succeed at this level.

7. **If it is the case that too many Alberta students enter post-secondary programs with deficits in their mathematics background that may impede their success in the mandatory mathematics requirements, what are the most likely causes of this?**

   An over-emphasis on calculators and not enough time spent working through multi-step problems by hand are likely contributors. For example, the calculation $20 – 2 \times (3 + 8/2)$ involves four operations that must be performed in a specific order. When this expression is entered into a calculator, the student will only see the final answer of 6. Students need to work through a sufficient number of such problems one step at a time to understand the importance of the order of operations and to perform them correctly. Otherwise, they are likely to have great difficulty when faced with algebraic expressions involving multiple operations. As mentioned earlier in the findings of the report, algebra is the language of Mathematics and a strong foundation in basic algebra skills is key to success and understanding in mathematics.

Appendix 2

Standardized Assessment Test Results

Programme for International Student Assessment

- The Programme for International Student Assessment (PISA) was established by the Organisation for Economic Co-operation and Development (OECD) in 2000 and is administered every three years to test the achievement of 15-year-olds in reading, mathematics and science literacies.

- Sixty-five jurisdictions (countries/economies) participated in the most recent PISA study in 2012. This includes all 10 Canadian provinces (about 21,000 students from approximately 900 schools in Canada and nearly 2,500 students from 99 Alberta schools).

- PISA 2012 results:

  – Alberta remains above the international average for PISA participants in all three areas. However, Alberta's results have been declining, and a continued decline could result in Alberta falling below the average.

  – In mathematics, Alberta's score of 517 was on par with the Canadian average of 518. Ten jurisdictions ranked ahead of Alberta. This is a decline from 2003, when Alberta tied for first place with a score of 549.

Trends in International Mathematics and Science Study

- TIMSS is an international test conducted by International Association for the Evaluation of Educational Achievement (IEA) every four years. It started in 1995 and assesses Grades 4 and 8 student achievement in mathematics and science.

- Alberta participated in 1995, 1999, 2007 (grade 4 only) and 2011. Over 60 jurisdictions, including Alberta and two other Canadian provinces, participated in TIMSS in 2011.

- TIMSS 2011 results:

  – In mathematics, Alberta Grade 4 students scored 507, putting them above the international average but behind 20 other jurisdictions including Ontario and Quebec. Grade 8 students scored 505, putting them behind eight jurisdictions and right at the international average. Alberta's mathematics scores have declined since 1995, but Alberta scores remain at the international average.

Pan-Canadian Assessment Program

- PCAP is a Canadian test administered by the Council of Ministers of Education, Canada to test Grade 8 students on Mathematics, reading and science.
- The first PCAP assessment took place in 2007. It is administered every three years.
- Alberta performs better on PCAP than on international studies because PCAP tests different things; it is based on common elements of Canadian curricula, whereas international studies are not.
- PCAP 2013 results:
  - In mathematics, Alberta students are on par with the Canadian average and rank behind Quebec and Ontario. Compared to 2010, there has been a statistically significant improvement in mathematics achievement for both Alberta and Canada.

Diploma Examination Multiyear Reports

Alberta Government

Five-Year Diploma Examination Results

Province: Alberta

Mathematics 30-1

	2011/2012	2012/2013*	2013/2014	2014/2015	2015/2016**
Number of Students	n/a	19,897	21,358	20,951	20,492
School-Awarded Mark					
Standard of Excellence (%)	n/a	44.2	46.1	49.0	50.7
Acceptable Standard (%)	n/a	95.9	95.6	95.9	96.4
Average (%)	n/a	74.9	75.5	76.3	77.0
Standard Deviation (%)	n/a	14.3	14.4	14.4	14.4
Diploma Examination Mark					
Standard of Excellence (%)	n/a	35.9	27.9	31.6	25.9
Acceptable Standard (%)	n/a	80.9	75.1	76.1	70.7
Average (%)	n/a	69.1	64.2	65.6	62.2
Standard Deviation (%)	n/a	20.3	20.4	21.1	21.2

* The 2012/2013 results do not include students who were exempted from writing the examination because of the flooding in Calgary and southern Alberta.

** The 2015/2016 results do not include students who were exempted from writing the exam because of the Fort McMurray wildfires.

Source: https://education.alberta.ca/media/3273032/diploma-multiyear-province-report-table.pdf

- Students who attain the acceptable standard but not the standard of excellence will receive a final course mark between 50 percent and 79 percent, inclusive. Typically, these students have gained new skills and a basic knowledge of the concepts and procedures relative to the general and specific outcomes defined in the program of studies. They demonstrate mathematical skills as well as conceptual understanding, and they can apply their knowledge to familiar problem contexts.
- Students who attain the standard of excellence will receive a final course mark of 80 percent or higher. Typically, these students have gained a breadth and depth of understanding regarding the concepts and procedures, as well as the ability to apply this knowledge and conceptual understanding to a broad range of familiar and unfamiliar problem contexts.

Diploma Examination Multiyear Reports

Alberta Government

Five-Year Diploma Examination Results

Province: Alberta

Mathematics 30-2

	2011/2012	2012/2013*	2013/2014	2014/2015	2015/2016**
Number of Students	n/a	9,692	11,991	12,591	13,631
School-Awarded Mark					
Standard of Excellence (%)	n/a	18.9	21.1	23.8	24.9
Acceptable Standard (%)	n/a	91.6	92.8	93.2	94.7
Average (%)	n/a	66.6	67.5	68.4	69.2
Standard Deviation (%)	n/a	13.1	13.1	13.4	13.0
Diploma Examination Mark					
Standard of Excellence (%)	n/a	9.7	15.0	15.5	16.8
Acceptable Standard (%)	n/a	69.5	71.3	73.9	75.4
Average (%)	n/a	57.7	60.2	60.4	61.6
Standard Deviation (%)	n/a	16.2	17.8	17.1	16.9

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Provincial Achievement Test Multiyear Reports

Alberta Government

Province: Alberta

Mathematics 6 - All Students Writing

	2011/2012		2012/2013		2013/2014		2014/2015		2015/2016*	
	N	%	N	%	N	%	N	%	N	%
Participation										
Enrolled [a]	43211	100.0	44117	100.0	45709	100.0	47496	100.0	47512	100.0
Writing	39308	91.0	40104	90.9	41435	90.6	43103	90.8	43210	90.9
Absent [b]	1919	4.4	1573	3.6	2008	4.4	2105	4.4	2001	4.2
Excused	1984	4.6	2440	5.5	2266	5.0	2288	4.8	2301	4.8
Results Based on Number Enrolled										
Total Test										
Standard of Acceptable	32298	74.7	32221	73.0	33576	73.5	34788	73.2	34281	72.2
Standard of Excellence	7184	16.6	7250	16.4	7031	15.4	6685	14.1	6650	14.0
Below Acceptable Standard	7010	16.2	7883	17.9	7859	17.2	8315	17.5	8929	18.8
Results Not Available [c]	3903	9.0	4013	9.1	4274	9.4	4393	9.2	4302	9.1
Results Based on Number Writing										
Total Test										
Acceptable Standard	32298	82.2	32221	80.3	33576	81.0	34788	80.7	34281	79.3
Standard of Excellence	7184	18.3	7250	18.1	7031	17.0	6685	15.5	6650	15.4
Below Acceptable Standard	7010	17.8	7883	19.7	7859	19.0	8315	19.3	8929	20.7
Mean (%)	39308	61.2	40104	56.4	41435	57.1	43103	60.8	43210	64.1
Standard Deviation	39308	19.8	40104	20.0	41435	20.3	43103	20.2	43210	20.8

a Includes all students registered in Grade 6 and ungraded students in year 6 of schooling. School Authority results do not include students in home education programs.

b Includes students who were absent for the entire test or part of the test, and those who wrote but whose results were withheld.

c Includes students who were absent, excused by the superintendent, or who wrote but whose results were withheld. It is possible that some students, under different circumstances, could have demonstrated standards on the test.

* The 2015/2016 results do not include students who were exempted from writing the test because of the Fort McMurray wildfires.

Please read "Guidelines for Interpreting the Achievement Test Multiyear Reports."

Report Generated: Dec 03, 2016
Current data with count less than 6 suppressed for Oct 2016

Report Version 1.0
Data Current as of Nov 02, 2016

Source: https://education.alberta.ca/media/3273023/pat-multiyear-province-report-table.pdf

Provincial Achievement Test Multiyear Reports

Alberta Government

Province: Alberta

Mathematics 9 - All Students Writing

	2011/2012		2012/2013*		2013/2014		2014/2015		2015/2016**	
	N	%	N	%	N	%	N	%	N	%
Participation										
Enrolled [a]	41943	100.0	28019	100.0	43354	100.0	43279	100.0	43253	100.0
Writing	37626	89.7	24881	88.8	38646	89.1	38687	89.4	38697	89.5
Absent [b]	2538	6.1	1706	6.1	2625	6.1	2600	6.0	2333	5.4
Excused	1779	4.2	1432	5.1	2083	4.8	1992	4.6	2223	5.1
Results Based on Number Enrolled										
Total Test										
Standard of Acceptable	27863	66.4	18729	66.8	29075	67.1	28253	65.3	29314	67.8
Standard of Excellence	7467	17.8	5117	18.3	7489	17.3	7767	17.9	7558	17.5
Below Acceptable Standard	9763	23.3	6152	22.0	9571	22.1	10434	24.1	9383	21.7
Results Not Available [c]	4317	10.3	3138	11.2	4708	10.9	4592	10.6	4556	10.5
Results Based on Number Writing										
Total Test										
Acceptable Standard	27863	74.1	18729	75.3	29075	75.2	28253	73.0	29314	75.8
Standard of Excellence	7467	19.8	5117	20.6	7489	19.4	7767	20.1	7558	19.5
Below Acceptable Standard	9763	25.9	6152	24.7	9571	24.8	10434	27.0	9383	24.2
Mean (%)	37626	57.7	24881	60.2	38646	59.9	38687	59.3	38697	61.9
Standard Deviation	37626	19.9	24881	19.9	38646	19.7	38687	20.5	38697	19.8

a Includes all students registered in Grade 9 and ungraded students in year 9 of schooling. School Authority results do not include students in home education programs.

b Includes students who were absent for the entire test or part of the test, and those who wrote but whose results were withheld.

c Includes students who were absent, excused by the superintendent, or who wrote but whose results were withheld. It is possible that some students, under different circumstances, could have demonstrated standards on the test.

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Report Generated: Dec 03, 2016
Current data with count less than 6 suppressed for Oct 2016

Report Version 1.0
Data Current as of Nov 02, 2016

Appendix 3

Post-Secondary Entrance Data and Program Course Requirements

The percentage of students entering post-secondary studies has remained relatively stable the last five years with almost 60% of students entering post-secondary or apprenticeship studies within 6 years of leaving high school.

The Government of Alberta defines the 6 year post-secondary transition rate as the percentage of students in the grade 10 cohort who enter a post-secondary level program at an Alberta post-secondary institution or register in an Alberta apprenticeship program within six years of entering grade 10, adjusted for attrition. Also, an estimation of out of province post-secondary enrollment is applied.

Alberta Government

Preparation for Lifelong Learning, World of Work, Citizenship

High School to Post-Secondary Transition Rates

Province: Alberta

Details for 4 Year Rate

	Total Students	Transitioners		Number of Transitioners	Unadjusted Transition Rates	Estimated Attrition	Estimated Out-of-Province Post-Secondary	**Transition Rates**
		Post-secondary	Apprenticeship					
2011	45,812	14,433	1,093	15,526	33.9	1,036.3	1,671.1	**38.4**
2012	45,141	14,374	1,306	15,680	34.7	1,126.8	1,646.4	**39.4**
2013	45,239	14,638	1,342	15,980	35.3	1,158.1	1,510.8	**39.7**
2014	45,101	13,983	1,451	15,434	34.2	1,107.0	1,407.9	**38.3**
2015	44,394	13,309	1,405	14,714	33.1	1,016.1	1,333.3	**37.0**

Details for 6 Year Rate

	Total Students	Transitioners		Number of Transitioners	Unadjusted Transition Rates	Estimated Attrition	Estimated Out-of-Province Post-Secondary	**Transition Rates**
		Post-secondary	Apprenticeship					
2011	45,708	21,336	2,429	23,765	52.0	995.6	2,341.1	**58.4**
2012	45,554	21,739	2,360	24,099	52.9	976.1	2,329.2	**59.3**
2013	45,803	21,685	2,559	24,244	52.9	1,036.9	2,156.6	**59.0**
2014	45,131	21,382	2,757	24,139	53.5	1,125.0	2,125.8	**59.7**
2015	45,231	21,339	2,703	24,042	53.2	1,159.5	2,129.7	**59.4**

Source: Accountability Pillar Results for Annual Education Results Report (AERR), October 2016.

The mathematics requirements in post-secondary programs vary greatly depending on the type of program. Not surprisingly, STEM type programs have the greatest mathematics requirements whereas Art based programs tend to have the least number of mathematics courses required. This is reflected in the pre-requisite mathematics requirements at the various post-secondary institutions. The colleges and universities that offer certificate programs tend to have the greatest number of programs that do not require a specific mathematics pre-requisite. With the exception of the Arts programs, most university degree programs do have a mathematics pre-requisite. All but two of the trades have a mathematics pre-requisite requirement.

The following table summarizes the number of programs offered at each respective institution and the number of those programs that have a mathematics or mathematics-related course as part of the requirement for completion of the program. In general, if the institution requires the students to take a mathematics course as part of their program completion, there is a mathematics pre-requisite to get into the program.

Institution	Number of Programs	Number of Programs Requiring a Mathematics or Mathematics-Related Course
Ambrose University	5	3
Athabasca University	87	38
Bow Valley College	22	7
Burman University	21	16
Concordia University of Edmonton	13	11
Grande Prairie Regional College	47	39
Keyano College	45	30
Lakeland College	57	25
Lethbridge College	42	10
MacEwan University	58	26
Medicine Hat College	82	39
Mount Royal University	34	20
NorQuest College	32	6
Northern Alberta Institute of Technology	85	34
Northern Lakes College	44	16

Olds College	33	7
Portage College	31	16
Red Deer College	96	63
Southern Alberta Institute of Technology	88	35
St. Mary's University	16	13
The King's University	31	16
University of Alberta	160	132
University of Calgary	67	62
University of Lethbridge	99	75
Total	**1295**	**739**

From the chart above it can be determined that approximately 57% of post-secondary programs have some mathematics requirement within the program.

Appendix 4

Post-secondary Programs Mathematics Pre-requisites

The following post-secondary institutions were reviewed in the spring of 2016 for mathematics entrance requirements.

Ambrose University
Athabasca University
Bow Valley College
Burman University
Concordia University of Edmonton
Grande Prairie Regional College
Keyano College
Lakeland College
Lethbridge College
MacEwan University
Medicine Hat College
Mount Royal University
NorQuest College
Northern Alberta Institute of Technology
Northern Lakes College
Olds College
Portage College
Red Deer College
Southern Alberta Institute of Technology
St. Mary's University
The King's University
University of Alberta
University of Calgary
University of Lethbridge
Alberta Apprenticeship and Industry Training Trade Entrance Requirements

Mathematics Requirements	Program
Ambrose University	
1 program requires Mathematics 30-1	1. Biology
2 programs require Mathematics 30-2 or 30-1	1. Behavioural Science 2. Business Administration
Athabasca University	
6 programs require Mathematics 30-1	1. Architecture Major Bachelor of Science (4 year) 2. Architecture Major Bachelor of Science (4 year) 3. Computing and Information Systems University Certificate 4. Computing and Information Systems Major Bachelor of Science (4 year) Post Diploma 5. Computing and Information Systems Major Bachelor of Science (4 year) 6. Finance Major Bachelor of Commerce (4 year) Post Diploma
6 programs strongly recommend Mathematics 30-1	1. Accounting Major Bachelor of Commerce 2. Accounting Major Bachelor of Commerce (4 year) Post Diploma 3. Applied Mathematics Bachelor of Science (4 year) 4. Commerce Bachelor of Commerce (4 year) 5. e-Commerce Major Bachelor of Commerce 6. e-Commerce Major Bachelor of Commerce (4 year) Post Diploma
Bow Valley College	
2 programs require Mathematics 30-2 or 30-1	1. Pharmacy Technician Diploma 2. Business Administration
1 program requires Mathematics 20-1, 20-2 or 20-3	1. Nutrition Manager Certificate
1 program requires Mathematics 20-1 or 20-2	1. Practical Nurse Program
1 program requires Mathematics 10C	1. Interior Decoration
Burman University	
5 programs require Mathematics 30-2 or 30-1	1. All Bachelor of Arts courses 2. Bachelor of Education, Elementary 3. Bachelor of Science, Psychology 4. Bachelor of Science, General Studies 5. Bachelor of Science, Wellness Management

5 programs require Mathematics 30-1 or Mathematics 31	1. Bachelor of Applied Arts – All tracks
	2. Bachelor of Education, Secondary Biology Specialization or Biology Education Minor
	3. Bachelor of Education, Secondary – Mathematics Specialization or Mathematics Education Minor
	4. Bachelor of Education, Secondary – Social Studies Specialization
	5. Bachelor of Science, Biology
Concordia University of Edmonton	
2 programs require Mathematics 30-2 or 30-1	1. Bachelor of Science
	2. Bachelor of Management
Grande Prairie Regional College	
4 programs require Mathematics 30-2 or 30-1	1. Animal Health Technology
	2. Power Engineering
	3. University Transfer: Education
	4. University Transfer: Nursing
1 program requires Mathematics 30-2, 30-1 or Mathematics 31	1. University Transfer: Arts
7 programs require Mathematics 30-1	1. Computer System Technology
	2. University Transfer: Commerce
	3. University Transfer: Computing Science
	4. University Transfer: Engineering
	5. University Transfer: Kinesiology Science
	6. University Transfer: Management/Commerce
	7. University Transfer: Science
3 programs require Mathematics 20-1 or 20-2	1. Aboriginal Administration Diploma
	2. Business Administration
	3. Unit Clerk
2 programs require Mathematics 20-1, 20-2 or 20-3	1. Office Administration
	2. Parts and Materials Technician
2 programs require Mathematics 10C or 10-3	1. Motorcycle Mechanic
	2. Harley Davidson Technician Certification

Keyano College	
4 programs require Mathematics 30-2 or 30-1	1. Bachelor of Science, Nursing 2. Bachelor of Business Administration 3. Business Administration - Accounting 4. Business Administration - Management
2 programs require Mathematics 30-1	1. Bachelor of Science, Environmental Science 2. Environmental Technology
1 program requires Mathematics 10C	1. Office Administration
1 program requires Mathematics 20-1 or 20-2	1. Practical Nurse
Lakeland College	
19 programs require Mathematics 30-2 or 30-1	1. Agricultural Sciences - Agribusiness 2. Agricultural Sciences – Animal Health Technology 3. Business – General Business Major 4. Business – Accounting Major 5. Business – Real Estate Appraisal and Assessment Major 6. Business – Marketing Major 7. Business – Small Business & Entrepreneurship Major 8. Business – Accounting Technician 9. Business – Agribusiness 10. Energy & Petroleum Technology Heavy Oil Operations Technician 11. Energy & Petroleum Technology Heavy Oil Power Engineering 12. Environmental Sciences Conservation & Restoration Ecology (CARE) Major 13. Environnemental Sciences Environnemental Conservation Réclamation Major 14. Environmental Sciences Environmental Monitoring & Protection Major 15. Environmental Sciences – Wildlife & Fisheries Conservation Major 16. Interior Design – Interior Design Technology 17. University Transfer – Bachelor of Education (Elementary) 18. University Transfer – Bachelor of Science (Nursing) 19. University Transfer – Pre-dentistry

9 programs Mathematics 30-1 required, Mathematics 30-2 recommended for some courses	1. University Transfer – Bachelor of Commerce 2. University Transfer – Bachelor of Science 3. University Transfer – Bachelor of Science (Medical Laboratory) 4. University Transfer – Bachelor of Science (Nutrition/ Food Studies)/Pre-Nutrition 5. University Transfer – Pre-dental Hygiene 6. University Transfer – Pre-dentistry 7. University Transfer – Pre-medicine 8. University Transfer – Pre-pharmacy 9. University Transfer – Pre-veterinary Medicine
5 programs require Mathematics 20-1 or 20-2	1. Agricultural Sciences – Animal Science Technology 2. Agricultural Sciences – Crop Technology 3. Agricultural Sciences – General Agriculture 4. Agricultural Sciences – General Agriculture 5. Agricultural Sciences – Western Ranch & Cow Horse Certificate
5 programs require Mathematics 20-3	1. Fire & Emergency Services – Emergency Services Technology (EST) 2. Fire & Emergency Services – Firefighter (NFPA Standard 1001) 3. Human Services – Educational Assistant 4. Trades & Technology Pre-employment – Electrician 5. Trades & Technology Pre-employment – Street Rod Technologies
1 program recommends Mathematics 10-3	1. Health & Wellness – Health Care Aide
3 programs require Mathematics 10-3	1. Health & Wellness – Pre-employment Hairstylist 2. Trades & Technology Pre-employment – Hairstylist 3. Trades & Technology Pre-employment – Welding
1 program requires Mathematics 20-1, 20-2 or 20-3	1. Cours et programmes en ligne Aide-élève
1 program requires Mathematics 20-2	1. Trades & Technology Pre-employment – Instrument Technician
5 programs require 20-3, recommend Mathematics 30-3	1. Trades & Technology Apprenticeship Automotive Service Technician 2. Trades & Technology Apprenticeship Electrician 3. Trades & Technology Apprenticeship Heavy Equipment Technician 4. Trades & Technology Apprenticeship Gasfitter 5. Trades & Technology Apprenticeship Steamfitter-Pipefitter

1 program requires Mathematics 30-3	1. Trades & Technology Apprenticeship Instrument Technician
3 programs require Mathematics 10-3, recommend Mathematics 30-3	1. Trades & Technology Apprenticeship – Carpenter 2. Trades & Technology Apprenticeship Parts Technician 3. Trades & Technology Apprenticeship Welder
Lethbridge College	
9 programs require Mathematics 30-2 or 30-1	1. Business Administration 2. Civil Engineering Technology 3. Computer Information Technology 4. Engineering Design and Drafting Technology 5. Environmental Assessment and Restoration 6. Geomatics Engineering Technology 7. Interior Design Technology 8. Natural Resource Compliance 9. Renewable Resource Management
2 programs require Mathematics 20-1, 20-2 or 20-3	1. Agricultural and Heavy Equipment 2. Automotive Systems
1 program requires Mathematics 20-2	1. Community Health Promotion
1 program requires Mathematics 10C or 10-3	1. Culinary Careers
1 program requires Mathematics 20-1	1. Practical Nursing
MacEwan University	
11 programs require Mathematics 30-2 or 30-1	1. Accounting and Strategic Measurement 2. Bachelor of Arts in Psychology 3. Bachelor of Commerce 4. Bachelor of Science in Nursing 5. Business Management 6. Insurance and Risk Management 7. Legal Assistant 8. Library and Information Technology 9. Office Assistant 10. Psychiatric Nursing Diploma 11. Travel
3 programs require Mathematics 30-1	1. Bachelor of Arts in Economics 2. Bachelor of Science 3. Bachelor of Science in Engineering Transfer

1 program recommends Mathematics 31	1. Bachelor of Commerce
1 program requires Mathematics 31	1. Bachelor of Science in Engineering Transfer
Medicine Hat College	
9 programs require Mathematics 30-2 or 30-1	1. Bachelor of Business Administration 2. Business Administration 3. Computer Aided Drafting & Design & Technical Illustrator 4. Computer Information Systems 5. Environmental Reclamation Technician 6. Information Technology 7. Nursing 8. Paramedic 9. Power Engineering Technology
4 programs require Mathematics 30-2 or 30-1 or a 30-level second language	1. Arts 2. Journalism 3. Law 4. Social Work UT
3 programs require Mathematics 30-2 or 30-1 or a 30-level science	1. Occupational/Physical Therapist Assistant 2. Speech Language Pathologist Assistant 3. Environmental Science
13 programs require Mathematics 30-1	1. Chiropractor 2. Commerce, Management and Business Administration 3. Dental Hygiene 4. Dentistry 5. Engineering 6. Kinesiology 7. Medical Lab Science 8. Medicine 9. Nutrition 10. Optometry 11. Pharmacy 12. Science 13. Veterinary Medicine
4 programs require Mathematics 10C	1. Administrative Office Management 2. Administrative Office Professional 3. Global Tourism and Marketing 4. Travel Counsellor

5 programs require Mathematics 20-3, recommend Mathematics 30-3	1. Automotive Service Technician (Apprenticeship Trade) 2. Electrician (Apprenticeship Trade) 3. Heavy Equipment Technician (Apprenticeship Trade) 4. Plumber (Apprenticeship Trade) 5. Steamfitter/Pipefitter (Apprenticeship Trade)
2 programs require Mathematics 10-3, recommend Mathematics 30-3	1. Carpenter (Apprenticeship Trade) 2. Welder (Apprenticeship Trade)
1 programs requires Mathematics 31	1. Engineering
1 program requires Mathematics 20-1, 20-2 or 20-3	1. Hospital Unit Clerk
1 program requires Mathematics 30-1, 30-2 or 20-2	1. Information Technology
1 program recommend Mathematics 31	1. Optometry
1 program requires Mathematics 20-1 or 20-2	1. Practical Nurse
2 programs recommend Mathematics 10-3	1. Pre-employment Carpentry 2. Pre-employment Welding
1 program recommends Mathematics 20-3	1. Pre-employment Electrician
Mount Royal University	
8 programs require Mathematics 30-2 or 30-1	1. Bachelor of Arts Anthropology, English, History, Policy Studies, Psychology, Sociology, Spanish, undeclared 2. Bachelor of Arts Criminal Justice 3. Bachelor of Arts Interior Design 4. Bachelor of Business Administration – Accounting, General Management, Human Resources, Marketing 5. Bachelor of Health and Physical Education – Athletic Therapy, Ecotourism and Outdoor Leadership, Physical Literacy, Sport and Recreation Management 6. Bachelor of Interior Design 7. Bachelor of Nursing 8. Bachelor of Midwifery
2 programs require Mathematics 30-2 or 30-1 or a second language	1. Bachelor of Arts English, Languages and Cultures 2. Bachelor of Education – Elementary

3 programs require Mathematics 30-1	1. Aviation, Diploma 2. Bachelor of Computer Information Systems 3. Bachelor of Science – Cellular and Molecular Biology, Environmental Science, General Science, Geology, Health Science
1 program requires Mathematics 20-3	1. Environmental Science Certificate
NorQuest College	
2 programs require Mathematics 30-2 or 30-1	1. Accounting Technician 2. Pharmacy Technician
1 program requires Mathematics 10C or Mathematics 20-2	1. Administrative Professional
1 program requires Mathematics 8	1. Apprenticeship Prep
3 programs require Mathematics 20-1 or 20-2	1. Business Administration 2. Practical Nurse 3. Prep for Practical Nurse
2 programs require Mathematics 10C	1. Hospital Unit Clerk 2. Physical Therapy Assistant
1 program requires Mathematics 10C or 10-3	1. Service Industry Skills
2 programs require Mathematics 20-3	1. Therapeutic Recreation Certificate 2. Therapeutic Recreation Diploma
Northern Alberta Institute of Technology	
29 programs require Mathematics 30-2 or 30-1	1. Animal Health Technology 2. Applied Banking and Business 3. Architectural Technology 4. Bachelor of Business Administration 5. Biological Sciences Technology Environmental Sciences 6. Biological Sciences Technology Laboratory and Research 7. Biological Sciences Technology Renewable Resources 8. Biological Sciences Technology Year 1 9. Business Administration Year One 10. Business Administration Year One with English Language Training 11. Business for Journeymen Management Diploma 12. Chemical Engineering Technology 13. Chemical Technology 14. Civil Engineering Technology

	15. Combined Lab and X-Ray Technology 16. Construction Engineering Technology 17. Denturist Technology 18. Diagnostic Medical Sonography 19. Forest Technology 20. Geological Technology 21. Geomatics Engineering Technology 22. Industrial Heavy Equipment 23. Technology 24. Interior Design Technology 25. Landscape Architectural Technology 26. Magnetic Resonance 27. Medical Radiologic Technology 28. Occupational Health and Safety 29. Petroleum Engineering Technology
15 programs require Mathematics 30-1	1. Biomedical Engineering Technology 2. Computer Engineering Technology 3. Cytotechnology 4. Digital Media and IT 5. Electrical Engineering Technology 6. Engineering Design and Drafting Technology 7. Instrumentation Engineering Technology 8. Magnetic Engineering Technology 9. Mechanical Engineering Technology 10. Medical Laboratory Technology 11. Nanotechnology Systems 12. Network Engineering Technology 13. Power Engineering Certificate 14. Power Engineering Technology 15. Wireless Systems Engineering Technology 1 program requires Mathematics 30-2 1. Petroleum Engineering Technology
15 programs require Mathematics 10-3, recommend Mathematics 30-3	1. Auto Body Technician 2. Baker 3. Carpenter 4. Cook 5. Crane and Hoisting Equipment Operator - Boom Truck 6. Crane and Hoisting Equipment Operator - Mobile Crane 7. Floorcovering Installer

	8. Insulator 9. Ironworker 10. Ironworker - Metal Building Syst. Erector 11. Lather - Interior Systems Mechanic 12. Machinist 13. Outdoor Power Equipment Technician 14. Sheet Metal Worker 15. Structural Steel and Plate Fitter (Steel Fabrication)
7 programs require Mathematics 10C or 10-3	1. Auto Body Technician, Pre-employment 2. Baking 3. CNC Machinist Technician 4. Culinary Arts 5. Emergency Management 6. Industrial Emergency Management 7. Millwork and Carpentry
14 programs require Mathematics 20-3, recommend Mathematics 30-3	1. Automotive Service Technician 2. Boilermaker 3. Cabinetmaker 4. Communication Technician 5. Electrician 6. Gasfitter 7. Heavy Equipment Technician 8. Millwright 9. Painter and Decorator 10. Parts Technician 11. Plumber 12. Power Engineering Technology 13. Powerline Technician 14. Steamfitter/Pipefitter
1 program requires Mathematics 20-1	1. Automotive Service Technician, Pre-employment
10 programs require Mathematics 20-1 or 20-2	1. Computer Network Administrator 2. Dental Technology 3. Graphic Communications 4. Heating Ventilation Air Conditioning Refrigeration Technician 5. Personal Fitness Trainer 6. Photographic Technology

	7. Radio and Television - Radio 8. Radio and Television - Television 9. Veterinary Medical Assistant 10. Water and Wastewater Technician
1 program requires Mathematics 10C	1. Emergency Medical Technology Paramedic
1 program requires Mathematics 20-1, 20-2 or 20-3	1. Hospitality Management
2 programs require Mathematics 30-3	1. Instrument Technician 2. Refrigeration and Air Conditioning Mechanic
1 program requires Mathematics 10C or Mathematics 20-2	1. Medical Laboratory Assisting
1 program recommends Mathematics 10C	1. Pre-Business
Northern Lake College	
1 program requires Mathematics 30-1, 30-2 or 30-3	1. Business Administration Certificate (2016 - 2017)
2 programs require Mathematics 10-3, recommend Mathematics 30-3	1. Crane and Hoisting Equipment Operator – Boom Truck Apprenticeship 2. Welder Apprenticeship First Period
1 program requires Mathematics 20-3, recommend Mathematics 30-3	1. Electrician Apprenticeship First Period
2 programs require Mathematics 10C or 10-3	1. Office Administration 2. College and Career Preparation (Pre-Health Careers Math)
6 programs require Mathematics 20-1 or 20-2	1. Community Health Promotion Program - Certificate 2. Emergency Medical Responder 3. Emergency Medical Technologist Paramedic 4. Practical Nurse (Diploma) 5. Practical Nurse Year 1 of 2 6. Practical Nurse Year 2 of 2
4 programs require Mathematics 10-3	1. Health Care Aide 2. Health Care Aide/Prior Learning Assessment and Recognition 3. Health Care Aide ESTEP (Employed Student Tutored Education Program) 4. Educational Assistant Certificate
1 program requires Mathematics 20-3	1. Oilfield Operator Training
Olds College	
2 programs require Mathematics 30-2 or 30-1	1. Brewmaster and Brewery Operations Management 2. Animal Health Technology

17 programs require Mathematics 20-1 or 20-2	1. Hospitality and Tourism Management 2. Agricultural Management 3. Equine Science 4. Advanced Farrier Science 5. Veterinary Medical Receptionist 6. Veterinary Technical Assistant 7. Business Administration Sports Management Major 8. Turfgrass Management 9. Business Management Certificate 10. Fashion Marketing 11. Apparel Technology 12. Arboriculture Technician 13. Horticulture Technician 14. Land Analyst 15. Land Agent 16. Land and Water Resources 17. Agriculture and Heavy Equipment
2 programs require Mathematics 10C	1. Exercise Rider and Jockey Training 2. Race Horse Groom Training
1 program requires Mathematics 10-3	1. Landscape Gardener
Portage College	
3 programs require Mathematics 30-2 or 30-1	1. Business Administration Certificate 2. Natural Resources Technology 3. Food Science and Technology Diploma
5 programs require Mathematics 10C or 10-3	1. Early Learning & Childcare Certificate 2. Educational Assistant Certificate 3. Office Administration 4. Baking Certificate 5. Heavy Equipment Operator
1 program requires Mathematics 20-1, 20-2 or 20-3	1. Accounting Technician
3 programs require Mathematics 10-3, recommend 30-3	1. Culinary Arts 2. Hairstyling 3. Welder Apprenticeship
2 programs require Mathematics 10-3	1. Institutional Cook 2. Pre-Employment Cooking

4 programs require Mathematics 20-1 or 20-2	1. Emergency Medical Technician Blended 2. Emergency Medical Technology Paramedic 3. Practical Nurse 4. Practical Nurse Blended Delivery
1 program requires 10C	1. Power Engineering
2 programs require Mathematics 20-3, recommend 30-3	1. Electrician Apprenticeship 2. Steamfitter – Pipefitter Apprenticeship
Red Deer College	
6 programs require Mathematics 30-2 or 30-1	1. Aviation Certificate 2. Business Administration Diploma 3. Bachelor of Science – Human Ecology 4. Bachelor of Science Nursing University of Alberta collaborative program 5. Pharmacy Technician Diploma
3 programs recommend Mathematics 30-2 or 30-1	1. Certificate of Management 2. Occupational Therapist 3. Physiotherapist Assistant Diploma
1 program requires Mathematics 20-2, 20-1, 30-2 or 30-1	1. Practical Nurse Diploma
30 programs require Mathematics 30-1	1. Bachelor of Science, Agricultural Food Business Management 2. Bachelor of Science, Agriculture 3. Bachelor of Science, Atmospheric Science 4. Bachelor of Science – Biochemistry 5. Bachelor of Science – Biological Sciences 6. Carpenter Apprenticeship 7. Bachelor of Science or Pre-professional – Chiropractic 8. Bachelor of Commerce 9. Bachelor of Science or Pre-professional – Dentistry 10. Bachelor of Education/Science Combined 11. Electrical Engineering Technology Diploma 12. Bachelor of Science – Engineering 13. Bachelor of Science – Environmental & Conservation Sciences 14. Bachelor of Science – Environmental Management 15. Bachelor of Science – Environmental Science 16. Bachelor of Science – Forestry 17. Bachelor of Science – General

	18. Bachelor of Science – Geophysics 19. Health Care Aide Certificate 20. Bachelor of Science – Math & Economics 21. Bachelor of Science – Mathematics 22. Mechanical Engineering Technology 23. Bachelor of Science or Pre-professional – Optometry 24. Bachelor of Science – Nutrition & Food Science 25. Bachelor of Science or Pre-professional – Pharmacy 26. Bachelor of Science – Physics 27. Bachelor of Science – Physiology 28. Bachelor of Science – Psychology 29. Bachelor of Science – Statistics 30. Bachelor of Science or Pre-professional – Veterinary Medicine U of C and U of Saskatchewan transfer program
7 programs require Mathematics 20-3, recommend 30-3	1. Automotive Service Technician, Apprenticeship 2. Electrician Apprenticeship 3. Heavy Equipment Technician Apprenticeship 4. Millwright Apprenticeship 5. Plumber Apprenticeship 6. Sprinkler System Installer Apprenticeship 7. Steamfitter/Pipefitter Apprenticeship
1 program requires Mathematics 10C, 20-2 or 20-3	1. Automotive Service Certificate
1 program requires Mathematics 10C	1. Career and Academic Preparation
6 programs require Mathematics 10-3, recommend 30-3	1. Carpenter Apprenticeship 2. Cook Apprenticeship 3. Locksmith Apprenticeship 4. Parts Technician Apprenticeship 5. Water Well Driller Apprenticeship 6. Welder Apprenticeship
4 programs require Mathematics 31	1. Bachelor of Science – Engineering 2. Bachelor of Science – Math & Economics 3. Bachelor of Science – Mathematics 4. Bachelor of Science – Statistics
1 program requires Mathematics 30-3	1. Instrument Technician Apprenticeship
1 program requires Mathematics 10C or 20-2	1. Medical Laboratory Assistant Certificate

Southern Alberta Institute of Technology	
30 programs require Mathematics 30-2 or 30-1	1. Aircraft Maintenance Engineers Technology 2. Architectural Technology 3. Architectural Technologies 4. Avionics Technology 5. Broadcast Systems Technology 6. Business Administration 7. Business Administration – Automotive Management 8. Chemical Engineering Technology 9. Chemical Laboratory Technology 10. Dental Assisting 11. Diagnostic Medical Sonography 12. Electrical Engineering Technology 13. Electronics Engineering Technology 14. Energy Asset Management 15. Geomatics Engineering Technology 16. Geoscience Information Technology 17. Health Information Management 18. Hospitality Management 19. Information Technology 20. Instrumentation Engineering Technology 21. Mechanical Engineering Technology 22. Medical Laboratory Technology 23. Medical Radiologic Technology 24. Nuclear Medicine Technology 25. Petroleum Engineering Technology 26. Pharmacy Assistant 27. Power Engineering Technology 28. Power and Process Operations 29. Process Piping Drafting 30. Respiratory Therapy
5 programs require Mathematics 30-1	1. Bachelor of Business Administration 2. Bachelor of Science (Construction Project Management) 3. Civil Engineering Technology 4. Engineering Design and Drafting Technology 5. Environmental Technology
1 program requires Mathematics 30-2 or 20-1	1. Practical Nurse Diploma

1 program requires Mathematics 30-1, 30-2 or 30-3	1. Pre-Employment Refrigeration and Air Conditioning
3 programs require Mathematics 10C or 20-3	1. Administrative Information Management
	2. Legal Assistant
	3. Office Professional
4 programs require Mathematics 20-1 or 20-2	1. Aircraft Structures Technician
	2. Emergency Medical Technician
	3. Emergency Medical Technology– Paramedic
	4. Nutrition for Healthy Lifestyles
5 programs require Mathematics 20-1, 20-2 or 20-3	1. Automotive Service Technology
	2. Diesel Equipment Technician
	3. Pre-Employment Electrician, Millwright, Plumbing, Steamfitter-Pipefitter
	4. Railway Conductor
	5. Travel and Tourism
7 programs require Mathematics 10C or 10-3	1. Baking and Pastry Arts
	2. Butchery and Charcuterie Management
	3. Machinist Technician
	4. Non-Destructive Testing Foundations
	5. Pre-Employment Cabinetmaker, Carpenter, and Sheet Metal
	6. Professional Cooking
	7. Welding Technician
1 program requires Mathematics 10C or 20-2	1. Medical Laboratory Assistant
St. Mary's University	
5 programs require Mathematics 30-2, 30-1 or 30-level second language	1. Bachelor of Arts with a Major in English
	2. Bachelor of Arts with a Concentration in General Studies
	3. Bachelor in Arts with a Major in History
	4. Bachelor of Arts with a Major in Liberal Studies
	5. Bachelor of Arts with a major in Psychology
5 programs require Mathematics 30-1	1. Bachelor of Science with a Major in Biology
	2. Business Transfer Program
	3. Bachelor of Science
	4. 4-year Biology Degree Program
	5. Biological Sciences Transfer Program

The King's University	
3 programs require Mathematics 30-2 or 30-1	1. Bachelor of Arts – Psychology (4-year) 2. Bachelor of Science – Biology (3-year) 3. Bachelor of Science – Environmental Studies Biology (4-year)
2 programs recommend Mathematics 30-2	1. Bachelor of Arts – Environmental Studies (4-year) 2. Bachelor of Arts – PHES (4-year)
9 programs require Mathematics 30-1	1. Bachelor of Arts – Chemistry (3-year) 2. Bachelor of Arts – Environmental Studies Chemistry (4-year) 3. Bachelor of Science Chemistry (3-year) 4. Bachelor of Science – Biology (4-year) 5. Bachelor of Science Chemistry (4-year) 6. Bachelor of Science Computer Science (4-year) 7. Bachelor of Science – Environmental Studies Chemistry (4-year) 8. Bachelor of Science – Environmental Studies Computing Science (4-year) 9. Bachelor of Commerce (4-year)
University of Alberta	
2 programs require Mathematics 30-2 or 30-1	1. Bachelor of Arts, Mathematics major 2. Bachelor of Arts, Psychology minor
1 program recommends Mathematics 30-2 or 30-1	1. Bachelor of Education in Elementary Education
10 programs require Mathematics 30-1	1. Bachelor of Science in Agriculture 2. Bachelor of Education in Secondary Education CTS: Business, Administration, and Finance, or CTS Computing Science 3. Bachelor of Education in Secondary Education: General Sciences 4. Bachelor of Education in Secondary Education: Physical Sciences 5. Bachelor of Education in Secondary Education: Physics 6. Bachelor of Education in Secondary Education: Mathematics 7. Bachelor of Science in Engineering 8. Bachelor of Arts in Native Studies: Psychology, Business

	9. Bachelor of Arts in Native Studies: Economics, Mathematics 10. Bachelor of Science General
2 programs require Mathematics 31	1. Bachelor of Arts, Mathematics major 2. Bachelor of Science in Engineering
2 programs recommend Mathematics 31	1. Bachelor of Education in Secondary Education: Mathematics 2. Bachelor of Arts in Native Studies: Economics, Mathematics
University of Calgary	
1 program require Mathematics 30-2 or 30-1	1. Bachelor of Nursing
2 programs recommend Mathematics 30-2 or 30-1	1. Bachelor of Arts, Economics 2. Bachelor of Arts, Geography
51 programs require Mathematics 30-1	1. Bachelor of Commerce, Accounting 2. Bachelor of Science, Actuarial Science 3. Bachelor of Science, Applied Chemistry 4. Bachelor of Science, Applied Mathematics 5. Bachelor of Science, Astrophysics 6. Bachelor of Science, Biochemistry (honours only) 7. Bachelor of Science, Bioinformatics (honours only) 8. Bachelor of Science, Biological Sciences 9. Bachelor of Science, Biomechanics 10. Bachelor of Science, Biomedical Sciences (honours only) 11. Bachelor of Commerce, Business Process Management 12. Bachelor of Commerce, Business Technology Management 13. Bachelor of Science, Cellular, Molecular and Microbial Biology (honours only) 14. Bachelor of Science in Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering 15. Bachelor of Science in Engineering, Civil Engineering 16. Bachelor of Science, Chemistry 17. Bachelor of Science, Computer Science 18. Bachelor of Science, Ecology (honours) 19. Bachelor of Science in Engineering, Electrical Engineering 20. Bachelor of Education, Mathematics, Science

21. Bachelor of Education, Natural Sciences
22. Bachelor of Commerce, Energy Management
23. Bachelor of Commerce, Entrepreneurship and Innovation
24. Bachelor of Science, Environmental Science
25. Bachelor of Kinesiology, Exercise and Health Physiology
26. Bachelor of Commerce, Finance
27. Bachelor of Commerce, General Commerce
28. Bachelor of Science, General Mathematics
29. Bachelor of Science in Engineering, Geomatics Engineering
30. Bachelor of Health Sciences, Health and Society (honours only)
31. Bachelor of Commerce, Human Resources and Organizational Dynamics
32. Bachelor of Commerce, International Business
33. Bachelor of Kinesiology, Leadership in Pedagogy and Coaching
34. Bachelor of Commerce, Marketing
35. Bachelor of Science in Engineering, Mechanical Engineering
36. Bachelor of Kinesiology, Mind Science
37. Bachelor of Science, Natural Sciences
38. Bachelor of Science, Neuroscience
39. Bachelor of Science in Engineering, Oil and Gas Engineering
40. Bachelor of Commerce, Operations Management
41. Bachelor of Commerce, Personal Financial Planning
42. Bachelor of Science, Physics
43. Bachelor of Science, Plant Biology (honours only)
44. Bachelor of Science, Pure Mathematics
45. Bachelor of Commerce, Risk Management and Insurance
46. Bachelor of Science in Engineering, Software Engineering
47. Bachelor of Science, Statistics
48. Bachelor of Commerce, Supply Chain Management
49. Bachelor of Commerce, Tourism Management
50. Bachelor of Commerce, Tourism Management and Marketing
51. Bachelor of Science, Zoology (Honours)

15 programs require Mathematics 31	1. Bachelor of Science, Actuarial Science 2. Bachelor of Science, Applied Mathematics 3. Bachelor of Science, Astrophysics 4. Bachelor of Science, Biomechanics 5. Bachelor of Science in Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering 6. Bachelor of Science in Engineering, Civil Engineering 7. Bachelor of Science in Engineering, Electrical Engineering 8. Bachelor of Science in Engineering, Geomatics Engineering 9. Bachelor of Science, General Mathematics 10. Bachelor of Science in Engineering, Mechanical Engineering 11. Bachelor of Science in Engineering, Oil and Gas Engineering 12. Bachelor of Science, Physics 13. Bachelor of Science, Pure Mathematics 14. Bachelor of Science in Engineering, Software Engineering 15. Bachelor of Science, Statistics
University of Lethbridge	
12 programs require Mathematics 30-2 or 30-1	1. Bachelor of Arts Agricultural Studies, Archaeology and Geography (conc. GIS), Economics, Geography (conc. GIS) 2. Bachelor of Science Agricultural Biotechnology 3. Bachelor of ScienceArchaeology and Geography (conc. GIS), Computer Science, Computer Science and Geographical Information Science 4. Bachelor of Health Sciences Public Health major 5. Bachelor of Nursing 6. Computer Science, First Nations' Governance, General Management, Human Resource Management and Labour Relations, Information Systems, International Management, Marketing, Political Science 7. First Nations' Governance, General Management, Human Resource Management and Labour Relations, Information Systems, International Management, Marketing 8. Pre-Bachelor of Arts/Bachelor of Education Arts and Science Major: Economics

	9. Pre-Bachelor of Management/Bachelor of Education Computer Science, First Nations' Governance, General Management, Human Resource Management and Labour Relations, Information Systems, International Management, Marketing, Political Science 10. Pre-Post-Diploma Bachelor of Management/ Bachelor of Education Management Majors: First Nations' Governance, General Management, Human Resource Management and Labour Relations, Information Systems, International Management, Marketing 11. Bachelor of Arts/Bachelor of Management Arts and Science Major: Economics Management Majors: First Nations' Governance, General Management, Human Resource Management and Labour Relations, Information Systems, International Management, Marketing, Political Science 12. Bachelor of Science/Bachelor of Management Arts and Science Major: Computer Science Management Majors: First Nations' Governance, General Management, Human Resource Management and Labour Relations, Information Systems, International Management, Marketing, Political Science
1 program recommends Mathematics 30-2 or 30-1	1. Bachelor of Arts Sociology, Geography, Urban and Regional Studies
10 programs require Mathematics 30-1	1. Bachelor of Science 2. Bachelor of Science Biochemistry, Biological Sciences, Chemistry, Environmental Science, Mathematics, Neuroscience, Physics, Remote Sensing 3. Professional Transfer programs Engineering Transfer Program Academic Objective: Dentistry, Veterinary Medicine 4. Bachelor of Management Accounting, Economics, Finance 5. Post-Diploma Bachelor of Management Accounting, Finance 6. Pre-Bachelor of Science/ Bachelor of Education Arts and Science Majors: Biological Sciences, Chemistry, Geography, Mathematics, Physics, General Major in the Sciences

	7. Pre-Bachelor of Management/Bachelor of Education Management Majors: Accounting, Economics, Finance 8. Pre-Post-Diploma Bachelor of Management/ Bachelor of Education Management Majors: Accounting, Finance 9. Bachelor of Arts/Bachelor of Management Majors: Accounting, Economics, Finance 10. Bachelor of Science/Bachelor of Management Arts and Science Majors: Biological Sciences, Chemistry, Mathematics, Physics, General Major in the Sciences Management Majors: Accounting, Economics, Finance
2 programs recommend Mathematics 31	1. Bachelor of Science Agricultural Biotechnology 2. Biochemistry, Biological Sciences, Chemistry, Environmental Science, Mathematics, Neuroscience, Physics, Remote Sensing
Alberta Apprenticeship and Industry Training Trade Entrance Requirements	
26 trades require Mathematics 10-3, recommend 30-3	1. Baker 2. Bricklayer 3. Cabinetmaker 4. Carpenter 5. Concrete Finisher 6. Cook 7. Crane and Hoisting Equipment Operator 8. Floor Covering Installer 9. Glazier 10. Hairstylist 11. Insulator 12. Ironworker 13. Lather-Interior Systems Mechanic 14. Locksmith 15. Painter and Decorator 16. Parts Technician 17. Sheet Metal Worker 18. Structural Steel and Plate Fitter 19. Tilesetter 20. Water Well Driller 21. Welder 22. Auto Body Technician 23. Landscape Gardener

	24. Machinist 25. Outdoor Power Equipment Technician 26. Recreation Vehicle Service Technician
19 trades require Mathematics 20-3, recommend 30-3	1. Agricultural Equipment Technician 2. Appliance Service Technician 3. Automotive Service Technician 4. Boilermaker 5. Communication Technician 6. Electric Motor Systems 7. Electrician 8. Elevator Constructor 9. Gasfitter 10. Heavy Equipment Technician 11. Millwright 12. Motorcycle Mechanic 13. Natural Gas Compression Technician 14. Plumber 15. Power Systems Electrician 16. Powerline Technician 17. Sprinkler Systems Installer 18. Steamfitter – Pipefitter 19. Transport Refrigeration Technician
2 trades require Mathematics 30-3	1. Instrument Technician 2. Refrigeration and Air Conditioning Mechanic

Appendix 5

Post-secondary Programs with Mathematics or Mathematics Related Courses Within the Program

The purpose of this report was to determine the areas within post-secondary programs offered by Alberta institutions and their requirements for mathematics based courses for successful completion. The requirements were broken into optional mathematics courses and mandatory requirements for each program offered at all post-secondary schools.

Below is high level summary, organized by institution, of the number of programs that have optional and mandatory requirements for successful completion. Specific details of the courses can be found in the separate document titled Required and Optional Post-Secondary Mathematics Courses by Program. (Provided to Minister Eggen's Office on November 21, 2016.)

Ambrose University: 5 programs offered

Optional Mathematics Requirements

- 3 programs require 2 optional mathematics courses
- 2 programs do not have optional mathematics requirements

Mandatory Mathematics Requirements

- 2 programs have 2 required mathematics courses
- 1 program has 3 required mathematics course

Athabasca University: 87 programs offered

Optional Mathematics Requirements

- 10 programs require 1 optional mathematics based course
- 18 programs require 2 optional mathematics based courses
- 3 programs require 4 optional mathematics based courses
- 2 programs require 14 optional mathematics based courses to complete the technician level

- 1 program requires 15 optional mathematics based courses
- 53 programs have no optional mathematics

Mandatory Mathematics Requirements

- 20 programs require 1 mandatory mathematics based course
- 6 programs require 2 mandatory mathematics based courses
- 8 programs require 3 mandatory mathematics based courses
- 3 programs require 4 or more mandatory mathematics based courses
- 1 program has two streams for completion with different mathematics based course requirements
- 49 programs have no mandatory mathematics based courses

Bow Valley College: 22 programs offered

Optional Mathematics Requirements

- 1 program requires 1 optional mathematics course
- 21 programs have no required optional mathematics course

Mandatory Mathematics Requirements

- 4 programs require 1 mandatory mathematics based course
- 1 program requires 2 mandatory mathematics based courses
- 2 programs require 3 mandatory mathematics based courses
- 15 programs have no mandatory mathematics based course requirements

Burman University: 21 programs offered

Optional Mathematics Requirements

- 2 programs require 1 optional mathematics based course
- 3 programs require 2 optional mathematics based courses
- 1 program requires 6 optional mathematics based courses
- 3 programs require 7 optional mathematics based courses

Mandatory Mathematics Requirements

- 6 programs require 1 mandatory mathematics based course
- 4 programs require 2 mandatory mathematics based courses
- 3 programs require 3 mandatory mathematics based courses
- 1 program requires 4 mandatory mathematics based courses
- 1 program requires 5 mandatory mathematics based course
- 1 program requires 12 mandatory mathematics based course
- 5 programs have no mandatory mathematics based courses

Concordia University of Edmonton: 13 programs offered

Optional Mathematics Requirements

- 5 programs require 2 optional mathematics based courses
- 2 programs require 3 optional mathematics based courses
- 3 programs require 4 optional mathematics based courses

Mandatory Mathematics Requirements

- 4 programs have 1 mandatory mathematics based course
- 4 programs require 2 mandatory mathematics based courses
- 1 program requires 5 mandatory mathematics based courses
- 1 program requires 6 mandatory mathematics based courses
- 1 program requires 9 mandatory mathematics based course
- 2 programs have no mandatory mathematics based courses

Grande Prairie Regional College: 47 programs offered

Optional Mathematics Requirements

- 2 programs require 1 optional mathematics based course
- 2 programs require 2 optional mathematics based courses
- 2 programs optional courses that may be mathematics based but do not specify the number

Mandatory Mathematics Requirements

- 11 programs have 1 mandatory mathematics based course
- 17 programs require 2 mandatory mathematics based courses
- 5 programs requires 3 mandatory mathematics based courses
- 4 programs requires 4 mandatory mathematics based courses
- 1 program requires 6 mandatory mathematics based course
- 1 program requires 6 mathematics courses for majors and 3-5 courses for minors
- 8 programs have no mandatory mathematics based courses

Keyano College: 45 programs offered

Optional Mathematics Requirements

- 1 program requires 1 optional mathematics based course
- 1 program requires 2 optional courses that may be mathematics based
- 4 programs require 4 optional courses that may be mathematics based

Mandatory Mathematics Requirements

- 12 programs have 1 mandatory mathematics based course

- 10 programs require 2 mandatory mathematics based courses
- 5 programs requires 3 mandatory mathematics based courses
- 2 programs requires 4 mandatory mathematics based courses
- 1 program requires between 7 and 11 courses for majors and 4-6 courses for minors
- 15 programs have no mandatory mathematics based courses

Lakeland College: 57 programs offered

Optional Mathematics Requirements

- 5 programs require 1 optional mathematics based course
- 4 programs require 2 optional courses that may be mathematics based

Mandatory Mathematics Requirements

- 14 programs have 1 mandatory mathematics based course
- 7 programs require 2 mandatory mathematics based courses
- 3 programs requires 3 mandatory mathematics based courses
- 1 program requires 4 mandatory mathematics based courses
- 32 programs have no mandatory mathematics based courses

Lethbridge College: 42 programs offered

Optional Mathematics Requirements

- 2 programs require 2 optional mathematics based courses
- 1 program requires 3 optional mathematics based courses
- 1 program requires 4 optional mathematics based courses

Mandatory Mathematics Requirements

- 6 programs require 1 mandatory mathematics based course
- 1 program requires 2 mandatory mathematics based courses
- 3 programs requires 3 mandatory mathematics based courses
- 32 programs have no mandatory mathematics based courses

MacEwan University: 58 programs offered

Optional Mathematics Requirements

- 5 programs require students to complete 1 optional mathematics based course
- 3 programs require 2 optional mathematics based courses
- 2 programs require 3 optional mathematics based courses
- 8 programs allow students to take electives from mathematics based courses, but do not provide a specific number

Mandatory Mathematics Requirements

- 14 programs require 1 mandatory mathematics based course
- 3 programs require 2 mandatory mathematics based courses
- 3 programs requires 3 mandatory mathematics based courses
- 1 program requires 4 mandatory mathematics based courses
- 1 program requires 5 mandatory mathematics based courses
- 1 program requires 6 mandatory mathematics based courses
- 1 program requires 12 mandatory mathematics based courses
- 1 program requires 13 mandatory mathematics based courses
- 1 program requires 19 mandatory mathematics based courses
- 32 programs have no mandatory mathematics based courses

Medicine Hat College: 82 programs offered

Optional Mathematics Requirements

- 3 programs require 1 optional mathematics based course
- 2 programs allow students to choose electives from mathematics based courses
- 77 programs have no mathematics based option courses

Mandatory Mathematics Requirements

- 16 programs require 1 mandatory mathematics based course
- 3 programs require 2 mandatory mathematics based courses
- 1 program requires 3 mandatory mathematics based courses
- 19 programs require students to follow requirements for universities they intend to transfer to
- 43 programs have no mandatory mathematics based courses

Mount Royal University: 34 programs offered

Optional Mathematics Requirements

- 2 programs require 1 optional mathematics based courses
- 1 program requires 3 optional mathematics based courses
- 1 program requires 4 optional mathematics based courses
- 15 programs allow students to choose optional mathematics courses as requirements, but do not specify the number of courses

Mandatory Mathematics Requirements

- 10 programs require 1 mandatory mathematics based course
- 6 programs require 2 mandatory mathematics based courses

- 4 programs requires 3 mandatory mathematics based courses
- 14 programs have no mandatory mathematics based courses

NorQuest College: 32 programs offered

Optional Mathematics Requirements

- 1 program requires 1 optional mathematics based course
- 2 programs require 2 optional mathematics based courses
- 1 program requires 3 optional mathematics based courses

Mandatory Mathematics Requirements

- 5 programs require 1 mandatory mathematics based course
- 1 program requires 2 mandatory mathematics based courses
- 26 programs have no mandatory mathematics based courses

Northern Alberta Institute of Technology: 85 programs offered

Optional Mathematics Requirements

- 2 programs require 2 optional Mathematics based courses
- 83 programs have no optional Mathematics based courses

Mandatory Mathematics Requirements

- 15 programs require 1 mandatory mathematics based course
- 11 programs require 2 mandatory mathematics based courses
- 4 programs require 3 mandatory mathematics based courses
- 2 programs require 4 mandatory mathematics based courses
- 1 program requires 5 mandatory mathematics based courses
- 1 program requires 7 mandatory mathematics based courses
- 51 programs have no mandatory mathematics based courses

Northern Lakes College: 44 programs offered

Optional Mathematics Requirements

- No programs require optional Mathematics courses

Mandatory Mathematics Requirements

- 14 programs require 1 mandatory mathematics based course
- 1 program requires 2 mandatory mathematics based courses
- 1 program requires 8 mandatory mathematics based courses
- 28 programs have no mandatory mathematics based courses

Olds College: 33 programs offered

Optional Mathematics Requirements

- No programs require optional Mathematics courses

Mandatory Mathematics Requirements

- 4 programs require 1 mandatory mathematics based course
- 3 programs require 2 mandatory mathematics based courses
- 26 programs have no mandatory mathematics based courses

Portage College: 31 programs offered

Optional Mathematics Requirements

- No programs require optional Mathematics courses

Mandatory Mathematics Requirements

- 11 programs require 1 mandatory mathematics based course
- 4 programs require 2 mandatory mathematics based courses
- 1 programs requires 3 mandatory mathematics based courses
- 15 programs have no mandatory mathematics based courses

Red Deer College: 96 programs offered

Optional Mathematics Requirements

- 7 programs require 1 optional mathematics based course
- 19 programs require 2 optional mathematics based courses
- 1 program requires 3 optional mathematics based courses
- 1 program requires 5 optional mathematics based courses
- 25 programs allow students to choose optional mathematics courses as requirements, but do not specify the number of courses

Mandatory Mathematics Requirements

- 12 programs require 1 mandatory mathematics based course
- 23 programs require 2 mandatory mathematics based courses
- 13 programs require 3 mandatory mathematics based courses
- 2 programs require 4 mandatory mathematics based courses
- 1 program requires 6 mandatory mathematics based courses
- 33 programs have no mandatory mathematics based courses
- 12 courses refer students to requirements for transfer to other post-secondary institutions

Southern Alberta Institute of Technology: 88 programs offered

Optional Mathematics Requirements

- No programs require optional Mathematics courses

Mandatory Mathematics Requirements

- 18 programs require 1 mandatory mathematics based course
- 9 programs require 2 mandatory mathematics based courses
- 8 programs requires 3 mandatory mathematics based courses
- 53 programs have no mandatory mathematics based courses

St. Mary's University: 16 programs offered

Optional Mathematics Requirements

- 1 program requires 1 optional mathematics based course
- 11 programs allow students to choose optional mathematics courses as requirements, but do not specify the number of courses

Mandatory Mathematics Requirements

- 4 programs require 1 mandatory mathematics based course
- 5 programs require 2 mandatory mathematics based courses
- 1 program requires 3 mandatory mathematics based courses
- 1 program requires 4 mandatory mathematics based courses
- 1 program requires 5 mandatory mathematics based courses
- 1 program requires 7 mandatory mathematics based courses
- 3 programs have no mandatory mathematics based courses

The King's University: 31 programs offered

Optional Mathematics Requirements

- 7 programs require 1 optional mathematics based course
- 1 program requires 2 optional mathematics based courses
- 18 programs allow students to choose optional mathematics courses as requirements, but do not specify the number of courses.

Mandatory Mathematics Requirements

- 4 programs require 1 mandatory mathematics based course
- 6 programs require 2 mandatory mathematics based courses
- 3 programs requires 3 mandatory mathematics based courses
- 1 program requires 4 mandatory mathematics based courses

- 1 program requires 6 mandatory mathematics based courses
- 1 program refers students to entrance requirements for university transfer
- 15 programs have no mandatory mathematics based courses

University of Alberta: 160 programs offered

Optional Mathematics Requirements

- 5 programs require 1 optional mathematics based course
- 2 programs require 2 optional mathematics based courses
- 2 programs require 3 optional mathematics based courses
- 1 program requires 5 optional mathematics based courses
- 86 programs require electives that may include courses that are mathematics based
- 64 programs do not require mathematics based option courses

Mandatory Mathematics Requirements

- 20 programs require 1 mandatory mathematics based course
- 25 programs require 2 mandatory mathematics based courses
- 23 programs require 3 mandatory mathematics based courses
- 12 programs require 4 mandatory mathematics based courses
- 5 programs require 5 mandatory mathematics based courses
- 11 program requires 6 mandatory mathematics based courses
- 4 programs require 7 mandatory mathematics based courses
- 1 program requires 8 mandatory mathematics based courses
- 4 programs requires 9 mandatory mathematics based courses
- 2 programs requires 10 mandatory mathematics based courses
- 3 programs requires 11 mandatory mathematics based courses
- 4 programs requires 13 mandatory mathematics based courses
- 1 program requires 14 mandatory mathematics based courses
- 17 programs require 15 or more mandatory mathematics based courses
- 28 programs have no mandatory mathematics based courses

University of Calgary: 67 programs offered

Optional Mathematics Requirements

- 61 programs require electives that may include courses that are mathematics based
- 2 programs recommend specific mathematics courses be taken as options
- 4 courses do not require mathematics based option courses

Mandatory Mathematics Requirements

- 4 programs require 1 mandatory mathematics based course
- 18 programs require 2 mandatory mathematics based courses
- 4 programs require 3 mandatory mathematics based courses
- 14 programs require 4 mandatory mathematics based courses
- 1 program requires 5 mandatory mathematics based courses
- 6 programs require 7 mandatory mathematics based courses
- 3 programs requires 10 mandatory mathematics based courses
- 1 program requires 14 mandatory mathematics based courses
- 11 programs require 15 or more mandatory mathematics based courses
- 5 programs have no mandatory mathematics based courses

University of Lethbridge: 99 programs offered

Optional Mathematics Requirements

- 79 programs require electives that may include courses that are mathematics based
- 2 programs recommend specific mathematics courses as options
- 18 programs do not require option courses that are mathematics based

Mandatory Mathematics Requirements

- 23 programs require 1 mandatory mathematics based course
- 21 programs require 2 mandatory mathematics based courses
- 8 programs require 3 mandatory mathematics based courses
- 5 programs require 4 mandatory mathematics based courses
- 3 programs require 5 mandatory mathematics based courses
- 1 program requires 6 mandatory mathematics based courses
- 1 program requires 7 mandatory mathematics based courses
- 1 programs requires 9 mandatory mathematics based courses
- 1 programs requires 10 mandatory mathematics based courses
- 2 programs requires 11 mandatory mathematics based courses
- 1 programs requires 12 mandatory mathematics based courses
- 1 program requires 15 or more mandatory mathematics based courses
- 7 programs require students to follow the mandatory courses from other programs offered at the institution
- 24 programs have no mandatory mathematics based courses

Alberta Apprenticeship and Industry Training: 51 programs offered

Optional Mathematics Requirements

- No programs have optional mathematics based course requirements

Mandatory Mathematics Requirements

- 16 programs require less than 5 hours of Mathematics
- 4 programs require between 5 – 9 hours of Mathematics
- 3 programs require between 10 – 14 hours of Mathematics
- 2 programs require between 15 – 19 hours of Mathematics
- 4 programs require between 20 – 24 hours of Mathematics
- 3 programs require between 25 – 29 hours of Mathematics
- 19 programs require over 30 hours of Mathematics

Appendix 6

Advisory Panel Themes

The Mathematics Curriculum Review Working Group met with seven panels of Mathematics stakeholders.

Panel 1: Mathematics Curriculum Experts: This panel consisted of seven individuals, three from Alberta Education and four from school jurisdictions, who are involved with the design and delivery of mathematics in Alberta schools.

Panel 2: Mathematics Heavy Post-Secondary Instructors: This panel consisted of ten instructors representing a variety of post-secondary institutions and programs from across the province. The programs represented required an in-depth study of mathematics and included engineering, physical sciences, business, medical technologies and Mathematics and statistical sciences.

Panel 3: Mathematics Moderate/Minimal Needs Post-Secondary Instructors: This panel consisted of five instructors representing a variety of post-secondary institutions and programs. The programs represented included nursing, business, apprenticeship and technologies.

Panel 4: K–9 Teachers: This panel consisted of six teachers from across the province.

Panel 5: 10–12 Teachers: This panel consisted of five teachers from across the province.

Panel 6: Mathematics Education Post-Secondary Instructors: This panel consisted of four instructors representing the University of Alberta, the Werklund School of Education (University of Calgary), Grande Prairie Regional College and the University of Lethbridge.

Panel 7: Post-Secondary Students: This three member panel represented NAIT, University of Alberta and MacEwan University.

Each of the panels was supplied with a list of questions prior to their meeting with the Working Group. At the meeting with the working group, each panelist provided their perspective on the answers to the questions. Panel members, as well as the Working Group, were encouraged to add questions or comments that they felt would provide clarification about their responses. The questions supplied to each group were not identical, they were customized to the experience and expertise of the group.

Though the questions were not identical, themes did emerge from an analysis of responses. The following nine themes were identified as being issues or interests expressed by several of the panels.

A. **Positive Attitudes by Students Toward Mathematics is Very Important –** identified in 6/7 panels. Common themes emerged that recognized the importance for students to be more confident, to persevere, to be okay with struggling, to be risk-takers and to learn from mistakes.

B. **Importance of Deep Understanding** – identified in 7/7 panels. Panel members noted that while memorizing steps, applying rote memory, or mechanically using an algorithm have their place, declarative knowledge or automaticity alone does not equal deep understanding. Students also need to be able to apply what they have learned in new situations/contexts. Some panelists felt that written response tasks on provincial assessments were very helpful in assessing student level of understanding, and recent clarifications made to Alberta's Mathematics program are helping to achieve this balance.

C. **Importance of Communication in Mathematics** – identified in 6/7 panels. Having students write to explain their thinking, to do presentations, to use mathematical language & vocabulary appropriately, were all very important in understanding mathematics problems and in deepening students' thinking in mathematics.

D. **Connectedness** – identified in 4/7 panels. Students need to connect what they have learned in one strand of mathematics to another and they need to connect what they have learned in mathematics with what they have learned in other subjects.

E. **Calculators & Technology** – were identified in 7/7 panels as a topic of conversation but there was no consensus as to whether/when/how they should be used.

Some general trends:

- introduce after foundational skills are mastered
- clarify when technology is to be used
- use as an assistive tool, not a replacement for understanding
- recognize that they make mathematics more accessible in some situations
- consider including Excel as an additional tool (Mathematics moderate panel and post-secondary student panel)
- consider using apps to replace graphing calculators (Mathematics moderate panel and 10-12 teacher panel).

F. **Mathematics Programs need to be Inclusive** – identified in 6/7 panels. Mathematics programs must meet the needs of a diverse group of students, not just those bound for post-secondary education. Classrooms are more inclusive and there are more students entering post-secondary with learning disabilities. Other panels identified calculators as important for supporting students with diverse learning needs.

G. **Support for Teachers is Important** – identified in 4/7 panels. Teachers may need support to teach the current curriculum, especially in elementary where teachers are not subject-area specialists. There is a need for modelling, for learning strong pedagogy. Change takes time – idea of having mathematics specialists even in elementary was raised but difficulty in finding specialists even in secondary in rural areas was noted. The mathematics education instructors and the K–9 teacher panels highlighted Elementary Mathematics Professional Learning Opportunities (EMPLO) as a good support for teachers and parents.

H. **Standardized Assessments (PATs and Diploma Exams)** – identified in 6/7 panels. Participants discussed how what gets measured on an assessment impacts what happens in the classroom, particularly in relation to provincial testing. Some examples cited were: as a calculator can be used on the grade 6 PAT, calculator use in classrooms is more prevalent; with the removal of the written response from the mathematics diploma exams (where students used to show their work) the focus is on simply the answer, not on the process to get the answer. There was a lot of discussion about reintroducing a written component to the diploma exam among the post-secondary mathematics instructor panels and the 10-12 teacher panel.

I. **Questions as to whether there is a decline in mathematics performance** – is this perception a reality? This was questioned in 5 panels. We were told by some teachers and post-secondary instructors that there are some problems, but things are not necessarily any worse than they were in past.

Appendix 7

Math Curriculum Review Working Group

John O'Connor (Working Group Chair) - Discipline Advisor for the Department of Mathematics and Statistics - MacEwan University

Gerda de Vries - Associate Chair, Undergraduate Department of Mathematical and Statistical Sciences, University of Alberta

Jeff Goldie - Physics 30 Examiner, currently on secondment to Alberta Education from Edmonton Public Schools

Elaine Beltaos, Associate Professor Mathematics, MacEwan University

Cornelia Bica, Mathematics Instructor, NAIT

Indy Lagu, Associate Professor, Department of Mathematics and Computing, Mount Royal University

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