UNIVERSITY OF CALGARY | FACULTY OF SCIENCE

CURRICULUM REVIEW REPORT
PROGRAM: NEW MATHEMATICS PROGRAM
DEPARTMENT: MATHEMATICS AND STATISTICS

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Curriculum Review Team

The Curriculum Review process has extended over a few years. Committee and team membership lists include all members having served on the committees/teams during parts or all of this period.

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Course Outcomes development and mapping: Alex Brudnyi, Alex de Leon, Anatoliy Swishchuk, Berndt Brenken, Chao Qiu, Cindy Sun, Claude Laflamme, Clifton Cunningham, Cristian Rios, Danny Glin, David Scollnik, Deniz Sezer, Elena Braverman, Gemai Chen, Gilad Gour, Hua Shen, Jim Stallard, JingjingWu, Joseph Ling, Keith Nicholson, Karen Seyffarth, Karoly Bezdek, Kristine Bauer, Larry Bates, Mark Bauer, Matthew Greenberg, Michael Cavers, Michaal Lamoureux, Mohammed Aiffa, Renate Scheidler, Robert Woodrow, Ryan Hamilton, Scott Robison, Thi Dinh, Tony Ware, Wenyuan Liao, Xuewen Lu, Ying Yan, Yousry Elsabrouty, Yuriy Zinchenko

Full-time faculty members teaching courses that support the program: All full-time faculty members in the Department of Mathematics and Statistics

Data analysis and Action plan: All faculty members and all sessional instructors invited to participate

Undergraduate Programs and Curriculum Committee: Kristine Bauer, Scott Robison, Cindy Sun, Mohammed Aiffa, Ryan Hamilton, Rohana Ambagaspitiya, Jim Stallard, Yuriy Zinchenko, Matthew Greenberg, Elena Braverman, Thi Dinh, Nancy Chibry, Joseph Ling, Diana Gibson (student), Jeremy Gillespie (student), Mathieu Weachter

Undergraduate Director and Chair of the Undergraduate Programs and Curriculum Committee: Nancy Chibry, Joseph Ling

Executive Summary

The new Mathematics program has recently been approved by the provincial government, and is going to be launched in Fall 2018. It will replace three existing programs – the Pure Mathematics program, the Applied Mathematics program and the Statistics program. Thus, it will play an extremely important role alongside the other two programs offered by the Department, namely, the General Mathematics program and the Actuarial Science program. It is more flexible than the three individual programs that it amalgamates to allow students to construct their academic portfolios. It will retain the standard of rigour and sophistication of the superseded programs, improve on soft-skills development, and in the case of honours students, provides a required research experience.

Survey results suggest that most students seem to be either satisfied or very satisfied with the existing Pure Mathematics, Applied Mathematics and Statistics programs. On the other hand, some students wish that Math 271 or 273 (including introduction to proofs and discrete mathematics) had been prerequisites for several senior level courses, something the new Mathematics program has already addressed: Math 271 or 273 will be a prerequisite for several key gateway courses. Developing soft-skills, promoting ethics and communications, sustainability and responsibility in relevant decisions are areas that lagged behind discipline knowledge in the existing programs. The capstone courses partially address this imbalance. The flexibility of the new Mathematics program creates some concerns about the potential diversity of the graduating profile. Advising and close monitoring of student course selection practices are definitely needed. We put forward action items summarized below:

1. Carefully evaluate the program through student feedback and other useful devices.
2. Provide adequate advertising and advising information to students and high schools.
3. Consider developing new concentrations, professionally certified degrees, certificates, interdisciplinary degree programs with other academic units.
4. Address students' concerns about employment, exploring possible industrial projects and external internships.

Overview and Context of the Program

The new Mathematics program was approved by the provincial government in 2017.

The idea of a new Mathematics program was first conceived in 2012. In time a formal proposal was submitted and approved at the university level, and was approved by the provincial government in 2017.

In Fall 2018, it will replace the three existing programs – Pure Mathematics, Applied Mathematics and Statistics. Just as in the three existing programs, students in the new Mathematics program will stretch their creative and lateral thinking skills to tackle increasingly complex challenges while becoming knowledgeable in several essential sub-disciplines of mathematics and statistics. This includes the ability to quantify and describe phenomena in mathematical terms, extract and focus on key features, and draw logical conclusions. On the other hand, compared to the three existing programs, the new Mathematics program reduces the number of required courses from 16 to 15, and allows various paths to graduation, as long as proficiency and sophistication level is achieved in two chosen areas and a capstone experience successfully completed. Many components of the three programs that have been streamlined. Students are expected to choose two specializations, for example, analysis and scientific computing, cryptography and statistics, financial mathematics and operational research, and other combinations that would not have been possible under the existing individual, separate programs.

The amalgamation of the Pure Mathematics and the Applied Mathematics program grew out of a recognition of the need to emphasize the unity of the discipline and thus to equip the next generations of students with knowledge and skills in both breadth and depth across this unified field. In the existing Pure and Applied programs, students are unnecessarily restricted to one of two rather narrowly defined sets of courses. The separation of the Pure Mathematics and the Applied Mathematics programs requires students to choose between either a relatively large number of theory courses or a relatively large number of methodology courses. Students who wanted to get both of these equally important and inherently related knowledge and skill sets had to take courses extra to their major field or, in many cases, pursue a double major or some major-minor combination. The new Mathematics program thus effects a significant shift in our belief in what would form the best training for future generations of mathematicians, who live in and contribute to a world increasingly characterized by inter-connectedness. Besides new course selection possibilities, what finally marks the distinction between the separated and the amalgamated programs is the proposed requirement of a capstone experience. Finally, as the proposal began to take shape, the Department included Statistics as one of several Concentrations for aspiring mathematicians. This results in an explicit recognition of the mathematical expertize our Statistics graduates obtain. Full detail has been provided in both Part A and Part B of the new program proposal and will not be repeated here.

As the new Mathematics program concerns more a change in vision than a change in the details of disciplinary contents, we mostly re-name, re-number and re-align the existing courses. This allows us to review everything pertinent to course delivery – e.g., course outcomes and methods of assessments – even in the new context of the Mathematics program, and the review process started long before the program was approved by the provincial government.

As it allows a more flexible course selection than the separate Pure and Applied programs the new Mathematics program takes a step to appear closer to the current General Mathematics program. However, there are some very significant differences between the new Mathematics program and the current General Mathematics program. The General Mathematics still allows a much greater course selection flexibility making it most readily one part of a mixed degree program. The new Mathematics program, on the other hand, remains the program that prepares graduate readily for immediate graduate level studies. There is no honours program for General Mathematics, but the honours capstone course for

the new Mathematics program brings students even closer to the graduate level research experience than the current separate programs do. In this regard, the new Mathematics and the current General Mathematics program actually drift further apart. That being said the introduction of the new Mathematics program does involve changes that will have impacts on the General Mathematics program. We refer the readers to the General Mathematics Report for more discussions.

We do not anticipate the amalgamation of the three programs per se will significantly change the number of majors.

Program Outcomes:

Upon successfully completing the program, students should

1. acquire basic mathematical and statistical knowledge at a postsecondary level which is achieved by completing a core set of courses (basic knowledge);

2. master one or more specialized areas in pure or applied mathematics, or statistics, being able to solve theoretical problems in their selected areas of expertise (advanced knowledge);;

3. be well versed in creating and evaluating mathematical proofs, adopt problem solving in mathematics and statistics as a formal process applying standard techniques to solve theoretical and applied problems, being fluent in the formal language of mathematics (mathematical rigor);

4. develop the ability to model phenomena from natural or social sciences or other areas using mathematics/statistics, apply mathematical (or statistical) models in order to address practical problems from various fields in science or engineering, translate real-world problems into formal mathematical or statistical language and back (applications and modeling);

5. solve problems with mathematical and statistical techniques, demonstrate the ability to contribute to the problem solving process by displaying original ideas and creative solutions and also use software packages which aid computations, such as computer algebra packages (e.g. Maple, Mathematica, Wolfram Alpha, etc.) or statistical software packages (e.g. R, SAS, MiniTab, S-Plus, etc.) being aware of strength and limitations of computer-based tools (problem solving);

6. assess the validity or accuracy of models in mathematics and statistics, embrace that there is often more than one solution path, and that different perspectives on a problem may enhance a chance of finding a solution, accept that mathematical and statistical results are not subject to change, since the language of mathematics gives a formal proof of the validity of statements but mathematical or statistical models or constructions can be improved over time in light of new perspectives, discoveries or technology (judgment, critical thinking);

7. be able to work effectively in teams to solve problems and present their conclusions both orally and in writing, produce written papers and oral presentations using proper mathematical formalism (including the grammar of equations, symbols, graphs and charts), demonstrate

responsibility for their own learning by meeting deadlines, quantify their contribution to collaborative projects, value mathematics and statistics as inherently honest subjects where assertions are always supported by proofs and uncertainties are quantified, present their data, results or opinions with honesty, including honesty about their limitations, uphold a high standard of accountability by habitually providing evidence to support claims, show integrity when reporting their contributions, and are encouraged to err on the side of generosity when giving credit for the original source of an idea or piece of work (ethics and communication);

8. be aware that all forms of sustainability (e.g. financial, environmental, etc.) are inherently quantitative questions, to adjust current practices to minimize consumption subject to constraints, be able to provide quantitative analysis of the problems discussed in society, e.g. in the media, use the expertise gained in their program to inform their opinions and to share their expertise when required, point out the misuse of mathematics or statistics, and to correct unwarranted conclusions based on the misuse of quantitative information (good citizens).

Guiding Questions

The following two guiding questions were selected not only for the new Mathematics programs, but also for the General Mathematics program and the Actuarial Science program

1. Where will students next apply the skills they acquire in this course in the context or upon completion of the new Math program?

2. What skills obtained in this course will a successful student be able to translate into a CV or resume item, or in support of a scholarship or other application?

Based on the data from the National Survey of Student Engagement, the Faculty of Science is seeking additional information regarding High-Impact Educational Practices.

1. Are High Impact Practices being used regularly in this program?
2. If not, what is preventing these practices from being used?

Action Plan

Action Plan:

Recommendation	Action Item	Who is Responsible?	Due Date
carefully evaluate the program starting the third year of the program	Launch annual surveys of students enrolled in the program starting with the third year of the program	Curriculum and calendar committees	**2020-2023**
Provide good advising tools after introduction of new math program,	- Collaborate with advisors from the USC - Introduce multiple templates on the web page and in the Academic Calendar outlining various paths to the completion of the degree - At least for the first three years, assign the Math Program Lead for students' advising - Monitor students' progress in the program	Math Program Lead, IT web designers, USC, the department head, the curriculum and calendar committees	2017-2021
Integrate more concentrations and professionally certified degrees	- *Promote concentration in statistics, with specialization in biostatistics* - *Apply, resources allowing, for turning the concentration into a professionally certified statistics program* - *Consider developing other concentrations (e.g. optimization and operational research)* -	Curriculum and calendar committees, the department head, Faculty members	2017-2021

Developing interdisciplinary degrees, collaboration with other departments and faculties	Consider development of collaborate degree in • mathematical finance (Haskayne School of Business) • mathematical ecology (Biological Sciences) • Data Science (computer Science)	Curriculum and calendar committees, the department head, Faculty members	**2020-2023**
Address students' concerns about future employment and their preparation for the industrial job market	• Introduce capstone and accessible group project courses • Explore possibilities of industrial projects and external internships	Curriculum and calendar committees, the department head, Faculty members	**2020-2023**
In collaboration with Faculty of Science, advertise our new math program at schools	• Discuss the new program with school counsellors and teachers • Together with Faculty of Science, advertise the new program in flyers, posters and during meetings with high school students	Special committee organized for this purpose	

Conclusion

Conclusion

The curriculum review was an extensive exercise to evaluate existing courses and programs and project the findings to the new math program which is expected to be introduced in fall 2018. The review found the current course stream coherent with the program outcomes. Some gaps and redundancies are already in the process of being cleared up, or have been cleared up too recently to be reflected in students and alumni surveys. While new program outperforms existing applied math, statistics and pure math programs in flexibility, potential for collaboration with other faculties and departments, possibility of incorporating various mathematical and statistical streams, it requires more resources in advising/mentoring students. For at least 2-3 years after the program is launched, students' progress and paths to graduation should be carefully monitored and evaluated. This problem has been adequately reflected in the Findings sections and Action Plan. The review allowed us to analyze high impact practices used or recommended for application in teaching mathematics. One of them is concerned with introducing a new capstone course in mathematics, which has been intensively discussed in the department. Another aspect is a possible introduction of more applied upper level courses, exploring the ways of introducing more close collaboration with industrial and financial institutions, including possible internships.