

Implementation Report on the 2016-2017 Cyclical Review of Mathematics

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INTRODUCTION

This is the first implementation report for the Mathematics cyclical program review that took place in 2016-2017. For each recommendation, the full language from the External Reviewers' Report has been included, along with the corresponding information about implementation from the Final Assessment Report. For each recommendation, the unit has provided an update on the progress or action made toward the implementation of that recommendation, followed by comments from the relevant dean(s) and the Program Review Sub-Committee. Taking into account the updates provided by the unit and the comments from the dean(s), the Program Review Sub-Committee will review the report and determine if all recommendations have been implemented satisfactorily or if a subsequent report will be required.

RECOMMENDATIONS PRIORITIZED FOR IMPLEMENTATION IN FINAL ASSESSMENT REPORT

Full Recommendations from External Reviewers' Report:

Recommendation #1: Develop program-level and course-level learning outcomes, and means to assess them, to supplement the degree-level learning outcomes presented in the Self Study. Use these to assist in studying whether any changes within programs are warranted, and whether the skills necessary for advancement to the next level (year or course) are being adequately developed and measured.

Recommendation #2: Subject to recommendation 1, undertake a curriculum mapping exercise where, for each individual program, or group of related programs, the places where each outcome is introduced and the places where each one is reinforced are identified. A curriculum mapping exercise for the MSc program may give some insight into ways to streamline the program so that other enhancements can be made.

Recommendation #3: Supplementary to 2, undertake a thorough curriculum review for all programs at all levels. Possible goals include efficient use of resources to allow expansion of the graduate program, optimization of existing programs and the introduction of new programs like Data Science, and whether course content / sequencing provides adequate preparation for successor courses.

Recommendation #5: Investigate whether teaching support resources (e.g. Labs, tutorials, marking) being used to their fullest potential. There appear to be situations where tutorials have a role to play, for example in courses like MA121, MA250 and perhaps MA222, where one of the primary objectives is effective communication of detailed, technical, mathematical arguments in written English. Make any appropriate changes needed for the benefit of students' learning and success.

Recommendation #7: Devise a strategy to stabilize and possibly increase the intake of students in the undergraduate programs. Consider seeking collaborations with international universities at the undergraduate level to maintain and improve the intake and quality of international students.		
Recommendation to be Implemented (from Final Assessment Report)	Responsibility for Implementation	Anticipated Completion Date
<p><i>Course Mapping, Curriculum Review, Program and Course Level Learning Outcomes</i> (Recommendations #1, #2, and #3);</p> <p><i>Teaching Support Resources</i> (Recommendation #5);</p> <p><i>Undergraduate Enrolment</i> (Recommendation #7):</p>	Department	<p>May 2018 (course mapping)</p> <p>December 2018 (curriculum review)</p> <p>December 2019 (learning outcomes)</p> <p>May 2020 (implement curriculum changes)</p>

Unit Update: The department has undertaken many curricular initiatives in response to this recommendation. We have developed learning outcomes for all undergraduate and graduate courses in Mathematics and Statistics offered in the past three academic years. First, learning outcomes were developed for courses taught in 2017–2018 and then were revised in 2018–2019. The program-level learning outcomes for BA/BSc Mathematics, BA/BSc Financial Mathematics, and MSc Mathematics were developed in 2018-2019. The learning outcomes for the PhD Math & Stat Modelling were included in the proposal brief prepared in 2017.

The course mapping for BA and BSc programs in Mathematics and Financial Mathematics has almost been completed. We expect to finalize it by the end of this term. As a result of the curriculum assessment, we have already made adjustments to some undergraduate courses and recommended schedules for BA/BSc Financial Math programs. The Department is currently working on the full curriculum audit/review of all undergraduate courses.

We have reviewed all our graduate courses and submitted a package with curriculum changes to 500- and 600-level courses. These changes included a significant clean-up of our graduate course offerings (deletion of stale courses and regularization of regularly-offered special topics courses) to more accurately reflect the graduate courses that we offer. Senate approved the changes on Jan. 9, 2020. We also created new graduate fields of concentration in the MSc program. There are six approved fields: Analysis and Geometry, Computational Finance, Discrete Mathematics and Algebra, Mathematical Modelling, Statistics and Data Analytics. With these approved changes, the Department is now well-placed to complete the course mapping for the MSc program and its optional fields of concentration.

All of our first-year and most of our second-year courses have labs or tutorials. In 2017, we introduced labs in MA122 (Intro to Linear Algebra) and MA222 (Linear Algebra), as well as tutorials in MA121 (Intro to Mathematical Proofs) and MA250 (Intro to Analysis). For more abstract courses in Mathematics, we found that tutorials, where students more actively communicate with lab coordinators, IAs, and each other, are more efficient than labs. For some applied courses in financial mathematics and statistics, we intensified the use of software in labs to improve students' practical skills. One idea is to have biweekly labs dedicated to applications of software in addition to regular biweekly labs in ST259 (Probability I), ST260 (Stats I), and MA270 (Financial Math I). In Fall

2018, we started adding tutorials in senior undergraduate courses in math (MA238 – Discrete Math) and statistics and probability (ST359 – Probability II) that have no labs but are critical for Math programs. Additionally, with the growth of the number of graduate teaching assistants (GTAs), it became possible to reintroduce marked assignments in upper-level courses and to introduce labs/tutorials to selected 3rd and 4th year undergraduate courses (e.g., MA370 – Financial Mathematics II, MA451 – Stochastic Calculus and MA470 – Financial Mathematics III).

The recent introduction of the BSc Data Science program, as well as the development of new double-major programs, such as a future BSc Mathematics and Physics, can help us to stabilize the intake of undergraduate students further. The Department also developed a new option in Data Analytics that will increase the number of students in math and stats courses. Another strategy is to introduce undergraduate for-credit certificates in Data Analytics and Quantitative Finance. There is the capacity for additional international students in undergraduate programs. The department is working with the admission office to promote the BA/BSc programs abroad. Additionally, we are working with Chongqing Jiaotong University in China to create a 2+2 program.

The Math Department is committed to the success of students registered in Math courses. Our approach is to maintain the high level of all our courses, and, at the same time, improve the learning experience of all our students. In past years, we observed a steady increase in enrollment in both the courses required for math students and the service courses. However, we expect a significant decrease in the number of course registrations in the next two years because the Department of Physics and Computer Science recently deleted MA121 (Intro to Proofs) and MA238 (Discrete Mathematics) from all Computer Science programs. Note that this decision was made without consulting with the Math Department and that all our previous recommendations regarding Math courses for Computer Science students were unfortunately ignored. As a result, we expect a loss of about 800 course registrations per year.

While curriculum review will be an ongoing process for the department, we believe that this recommendation has been completed.

FOS Decanal Comments: The Department has addressed each of the five recommendations appropriately, and have committed to monitoring the issues going forward.

Program Review Sub-Committee Comments: The committee appreciates the level of detail provided by the department, outlining the actions that have been taken since the review in support of the implementation of this set of recommendations. As acknowledged by both the department and the dean, regular examination of course and program curriculum is an ongoing process, which the department seems committed to. For the purposes of reporting, this recommendation is considered completed.

Full Recommendation from External Reviewers' Report: Undertake a program by program analysis of student success using data on hand, if such a study has not been done. Use the results to adjust admission requirements, curriculum, student support, or delivery as appropriate, and if necessary. Track student success changes that occur subsequent to any adjustments that are made, and make further adjustments as needed.		
Recommendation to be Implemented (from Final Assessment Report)	Responsibility for Implementation	Anticipated Completion Date

Evaluation of Student Success Data (Recommendation #4)	Department (and Dean of Science)	May 2020
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Unit Update: The department has undertaken several initiatives in response to this recommendation since the cyclical review took place. We have conducted several case studies, such as analyzing admission data to identify important indicators of student success. Our conclusion was that in addition to high school grades in Math and English, we need to pay attention to whether Math courses have been repeated. Our recommendations have been passed on to the admissions office.

Secondly, we analyzed student success in courses where labs and tutorials were recently introduced. A preliminary conclusion was that students performed better with the benefit of regular labs or tutorials. Our strategy is to introduce tutorials (to be led by PhD students) in all required senior courses. In Fall 2018, we did so for ST359 (Probability II). In Fall 2019, we included tutorials in MA238 (Discrete Mathematics). Starting next Fall, there will be mandatory tutorials in MA370 (Financial Mathematics II). To support all Math students in year 2, we are developing a new mentorship program that will connect PhD students with undergraduate students who need additional help with math and stats courses.

There were other examples in which the analysis of student success data helped us to make important adjustments to our courses and schedules. For instance, we replaced a full-year course in calculus by a sequence of two courses to help students better progress through the first year. Another change to the sequence of courses involves moving MA121 (Intro to Proofs) to the second term of year 1 and developing a more balanced allocation of senior math courses for financial math students.

The program-by-program analysis suggested by the reviewers is a valuable idea, but infeasible at the moment. First, the department does not have access to complete structured data concerning current students, including admission data and all grades. Some data sets, such as gradebooks, can be downloaded manually, but this is a long and inefficient process. Additionally, our limited resources do not permit a thorough longitudinal data analysis across multiple programs. We believe that the initiatives described above fulfil the intent of the recommendation, and we will continue to monitor student success going forward.

FOS Decanal Comments: The Department has addressed this recommendation appropriately. They are to be commended for developing and implementing tutorial sessions for their senior undergraduate students led by doctoral students; a win-win situation for those involved regarding learning and teaching respectively. Moreover, the Department has committed to on-going monitoring of student success.

Program Review Sub-Committee Comments: The committee applauds the department on undertaking these valuable student success initiatives in response to this recommendation, which will no doubt have a positive impact on student performance and satisfaction. The committee concurs with the dean that this recommendation has been addressed appropriately, agreeing also with both the department and the dean that student success is an ongoing initiative. No further reporting is required.

<p>Full Recommendation from External Reviewers' Report: Expand the graduate program by increasing intake to a stable level of about 10 new students per year, possible lengthening of the Master's program in some cases, and introduction of a PhD program. Pro-actively seek graduates from the BSc programs to continue into the MSc program, and consider the introduction of a partially online "professionalized" Master's program.</p>
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Explore the idea of a bridging program where students without specific training in, say, financial mathematics can take a suite of courses that will prepare them for graduate work in the area. Design strategies to make the transition into and between graduate programs simple, cost-effective and efficient.		
Recommendation to be Implemented (from Final Assessment Report)	Responsibility for Implementation	Anticipated Completion Date
<i>Expand Graduate Program</i> (Recommendation #6)	Department	September 2020

Unit Update: The PhD in Mathematical and Statistical Modelling was developed and approved in 2016-17. The first cohort of students started in Fall 2018. As of Winter 2020, we have admitted a total of 11 PhD students. Second, we created a course-based option in the MSc program – 5 Master students are in this option this year. This new option might be viewed as a partially “professionalized” Master’s program, along the lines suggested by the reviewers. These measures have helped us to increase the intake of students to the graduate programs. Over the past few years, the research funding in our department has increased significantly, allowing for an increase in the numbers of funded graduate student positions. This is reflected in our PhD program, which has now admitted 11 students in only its second year of existence, and which will likely grow to over 15 students by Fall 2020.

A mechanism that is already in place for bridging students from one area of study to our graduate program is the Qualifying Year. Students that apply to our graduate program that are deemed to not have the necessary background can be accepted as a Qualifying Year student and are prescribed a certain set of undergraduate courses. If the student completes these courses and achieves a B+ average, they are invited to apply for admission to our MSc program. The Qualifying Year pathway has been in place for a number of years and is something that we could advertise more to attract students from different backgrounds to our graduate program.

To optimize our use of resources, we started twinning senior undergraduate courses with graduate courses. This approach allows us to expand our course offerings every year and demonstrate to our students the richness and diversity of mathematics (including statistics and data science). With more graduate courses offered every year, we can expand our Master's program in several directions. First, we attract a larger number of our undergraduate students who can now complete the Master's program with a graduate field that is complementary to their undergraduate degree. For example, graduates from BA/BSc Financial Mathematics can complete the graduate program with a specialization in statistics and data analytics. The students in the course-based option of our MSc program now have more choices for their course selection, and hence we expect to have more students in this option. Additionally, our MSc program can be completed on a part-time basis. With a broader suite of course offerings, our part-time MSc program will be more attractive to potential students. In 2019-20, we have two part-time MSc students.

We believe that the aforementioned initiatives satisfy this recommendation made by the review committee.

FOS Decanal Comments: The actions suggested within this recommendation have been implemented by the Department. The Department is to be commended for their commitment to their graduate programs, and the Faculty will provide as much support as possible going forward to further enhance these efforts.

FGPS Decanal Comments: The department has made significant progress in broadening their graduate programs. In the Fall 2020 term, there are 29 graduate students registered (18 in the MSc program and 11 in the PhD program). In addition, there have been students taking advantage of the qualifying year option. Overall, the department has met or exceeded the recommendation.

Program Review Sub-Committee Comments: The committee applauds the department on the success of their new PhD program, which had not yet begun when the last cyclical review took place. The committee echoes the positive comments provided by the department and the deans of Science and FGPS on initiatives undertaken to attract students to its MSc and PhD programs. This recommendation is considered to be completed.

Full Recommendation from External Reviewers' Report: Review and clarify the roles and responsibilities of all "support" staff (administrative, Lab, TA, IA, CAS) as necessary.		
Recommendation to be Implemented (from Final Assessment Report)	Responsibility for Implementation	Anticipated Completion Date
<i>Teaching Support Staff</i> (Recommendation #8)	Department	September 2018

Unit Update: The roles and responsibilities of administrative assistants and lab coordinators are specified in their contracts. Every year, the department chair and the manager of the Faculty of Science review the performance of staff. During this process, we discuss and evaluate the roles and responsibilities of each staff member. Additionally, the responsibilities of staff and contract faculty are described in the respective collective agreements. In the end, there is not much flexibility for adjustments. For IAs and TAs working in computer labs, we have a detailed description of their roles and responsibilities. The students hired as IAs and GTAs meet with laboratory coordinators regularly and generally have a good understanding of their responsibilities. Additionally, there are training sessions for GTAs at the start of each Fall term. We continue examining the roles and responsibilities of GTAs in view of establishing a collective agreement between GTAs and the University later this year.

FOS Decanal Comments: This recommendation has been implemented.

Program Review Sub-Committee Comments: Comments provided by the department suggest that a regular examination of the roles of administrative staff is already being undertaken on an ongoing basis, which will continue to be done. The committee advocates that particular attention be paid to the roles and responsibilities of Instructional and Teaching Assistants, and that these students are provided with the opportunity to give feedback on their experiences. Given the ongoing processes outlined by the department, and the dean's assessment that this recommendation has been implemented, the recommendation is considered to be completed.

Full Recommendation from External Reviewers' Report: Consider a fund-raising effort among successful alumni, perhaps led by several of them, in order to create a new suite of awards to cover most programs offered by the department.
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Recommendation to be Implemented (from Final Assessment Report)	Responsibility for Implementation	Anticipated Completion Date
<i>Student Awards</i> (Recommendation #10)	Department and Dean of Science	May 2018

Unit Update: As was indicated in the unit response, this is an excellent recommendation, although its implementation is a challenge. The Department has been working with Faculties Development & Alumni Relations to find sources of financial support. Unfortunately, there has not been much success in this area. In 2019, we were actively discussing the involvement of one major Canadian bank in the development of the new BSc Data Science program; however, the discussion is still in progress.

We consider this recommendation to be an ongoing one and will continue to work with Development and Alumni Relations on it.

FOS Decanal Comments: The efforts of the Department to address this recommendation are both recognized and appreciated. They are committed to working with Development and Alumni Relations, and thus have implemented this recommendation.

Program Review Sub-Committee Comments: The committee encourages the department to continue to foster its relationship with Alumni Relations in support of this recommendation, but given that the completion of it is not entirely within the department’s control, and that actions have been taken to implement it, no further reporting on it is required.

ADDITIONAL COMMENTS

FOS Decanal Comments: The Department is thanked for addressing and successfully implementing each of the issues raised in the Review Report; no subsequent Implementation Report is necessary.

FGPS Decanal Comments: The Department has done an admirable job addressing the recommendations relative to the MSc and PhD programs. No subsequent Implementation Report is necessary.

Program Review Sub-Committee: The committee appreciates the level of detail provided by the department in outlining the actions that it has taken since the cyclical review to implement the recommendations that were prioritized by the deans in the Final Assessment Report and Implementation Plan. The committee is also grateful for the clarity in the deans’ responses around whether or not, from their perspective, a recommendation was considered to be completed. Several of the recommendations made by the review committee represent ongoing work that the department has demonstrated that it is committed to continuing. The committee concurs with the deans that no further reporting on these recommendations is required in advance of the department’s next cyclical review, scheduled as part of the 2023-2024 review cycle.

Subsequent Report Required: No

Next Cyclical Review: 2023-2024