

FINAL ASSESSMENT REPORT
Institutional Quality Assurance Program (IQAP) Review
Mathematics and Statistics Undergraduate Programs

Date of Review: February 12-13, 2018

*In accordance with the University Institutional Quality Assurance Process (IQAP), this final assessment report provides a synthesis of the external evaluation and the internal response and assessments of the **Mathematics and Statistics** undergraduate programs delivered by the Department of Mathematics and Statistics. This report identifies the significant strengths of the programs, together with opportunities for program improvement and enhancement, and it sets out and prioritizes the recommendations that have been selected for implementation.*

The report includes an Implementation Plan that identifies who will be responsible for approving the recommendations set out in the Final Assessment Report; who will be responsible for providing any resources entailed by those recommendations; any changes in organization, policy or governance that will be necessary to meet the recommendations and who will be responsible for acting on those recommendations; and timelines for acting on and monitoring the implementation of those recommendations.

Executive Summary of the Cyclical Program Review of the Undergraduate Programs in
Mathematics and Statistics

In accordance with the Institutional Quality Assurance Process (IQAP), the Department of Mathematics and Statistics submitted a self-study for the undergraduate programs in Mathematics and Statistics in December 2017 to the Vice-Provost, Faculty to initiate the cyclical program review of its undergraduate programs. The approved self-study presented program descriptions, learning outcomes, and analyses of data provided by the Office of Institutional Research and Analysis. Appendices to the self-study contained all course outlines associated with the program and the CVs for each full-time member in the department.

Two arm's length external reviewers, both from Ontario and one internal reviewer were endorsed by the Dean, Faculty of Science, and selected by the Vice-Provost, Faculty. The review team reviewed the self-study documentation and then conducted a site visit to McMaster University on February 12 - 13, 2018. The visit included interviews with the Provost and Vice-President (Academic); Vice-Provost, Faculty, Dean of the Faculty of Science, Chair of the department and meetings with groups of current undergraduate students, full-time faculty and support staff.

The Chair of the program and the Dean of the Faculty of Science submitted responses to the Reviewers' Report (July 2018). Specific recommendations were discussed and clarifications and corrections were presented. Follow-up actions and timelines were included.

Strengths

In their report (March 2018), the Review team noted the following strengths of the Mathematics and Statistics undergraduate programs:

- Flexibility of the program
- First year courses in mathematical computation and reasoning
- Actuarial and Financial Management
- High quality of students and faculty

Areas of Improvement

In their report, the Review Team identified some recommendations for areas of improvement including:

- Enhanced versions of courses to give a richer experience to the best students
- Exposure to data science earlier in the program
- More guidance for students especially targeted at opportunities
- Improved support for the Math Help Centre
- More engagement with other faculties

The Dean of the Faculty of Science, in consultation with the Chair of the Mathematics and Statistics department shall be responsible for monitoring the recommendations implementation plan. The details of the progress made will be presented in the progress report and filed in the Vice-Provost, Faculty's office.

Summary of the Reviewers' Recommendations with the Department's and Dean's Responses

Implementation Plan

| Recommendation | Proposed Follow-Up | Responsibility for Leading Follow-Up | Timeline for Addressing Recommendation |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------|
| 1a. Introduce aspects of data science early, perhaps even into Math 1MP3 | Intensively pursue the idea of introducing data science into the curriculum, at some level. Note that both Math 1MP3 instructors have reservations about fitting this material into the existing course. | Undergraduate committee, under guidance of associate chair (undergraduate) | One year for discussion, two or more years for implementation. |

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| 1b. Offer enhanced versions of some of level I and II courses | We will explore the details of creating enriched sections of our 1st-year required courses in linear algebra and calculus, and consider repercussions for upper-year courses, including possibly enhanced or honors versions of the curriculum in second year | Undergraduate committee, under guidance of associate chair (undergraduate) | Strike a committee to start work in summer 2018. |
| 1c. Expand teaching of communication skills | Create a list of courses that would be deemed to satisfy a "communications requirement", and create a requirement that students in honors programmes take at least one of the courses from the list. Syllabus (or the calendar copy) of each course would identify it as such. Examples of such courses are Math 4FM3, Math 3MB3, Math 3Z03, Math 4P06, Stats 4T06. | Undergraduate committee, under guidance of associate chair (undergraduate) | Summer 2018, for submission to AP&PC in Fall 2018, and addition to the calendar for 2019-20 |
| 1d. Increase emphasis on computing in upper level courses | Hold some workshops in department presenting practical ways to include computing element in upper-level courses. Then discuss whether to mandate this use and in what courses. | Undergraduate committee, under guidance of associate chair (undergraduate) | One year for information gathering, one year for further discussion |
| 1e. Consider aligning AFM courses more with exams, using consultation with actuarial expert. | Work with our shortly-to-be-hired actuarial teaching professor to conduct this review. | Chair, associate chair (undergraduate), David Lozinski, new faculty member | One year |
| 2a. Decrease tutorial sizes, at least in some classes | Consider whether TA budget would allow this, and what courses would benefit from a smaller tutorial. Also discuss how to improve attendance and TA training in order to make these more effective. | Chair, associate chair (undergraduate), Aaron Childs | One year |
| 2b. Have instructional assistants | The chair expects to be able to hire Chris McLean and Erin Clements as instructional assistants, with responsibilities for Math Help Centre, assistant course coordinators, acting as liaison for TA training, etc. | Chair | September 2018 |

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| 2c. Have more administrative support for undergraduate associate chair, especially for student advising} | Find out how this is done in other departments, decide on case to make to Faculty of Science | Chair | One year |
| 2d. Make the organisational support for Math Help Centre more permanent via an instructional assistant position and commit to funding of Math Help Centre | See response to Recommendation 2b. Discuss ways in which the Faculty of Science could make a commitment to its continued funding. | Chair, associate chair (undergrad), associate chair (grad) | One year |
| 2e. Hire more faculty, and also explore blended learning models to leverage technology to compensate for higher student/instructor ratio | Discuss using blended learning in some courses, make case to Faculty of Science for funding to do so | Undergraduate committee, under guidance of associate chair (undergraduate) | One year for initial discussions; two or more years to implement |
| 3a. Communicate rotating schedule of courses more effectively to students | Changes currently being made to course list on departmental website to implement this recommendation. All courses will be listed with informal description. Courses not being taught in current year will be listed in separate section. | Summer 2018 | Associate chair (undergraduate), staff of undergraduate team |
| 3b. Increase communication/consultation/transparency in departmental decision-making, perhaps through more frequent meetings | This can be implemented by the chair. | On-going | Chair |
| 3c. Explore opportunities to collaborate with other Faculties such as Business and Social Science | | | |

Further Summary from the Department:

Item 1a. There is strong departmental support for developing a stream of data science courses, and several options were discussed. One would be to work in cooperation with other programs in Science (or more broadly) to develop an interdisciplinary minor in data science. Another would be to develop a data science sub-plan within Mathematics and Statistics. Both options will require additional resources.

Item 1b. Adam Van Tuyl gave a detailed presentation about options for introducing enhanced versions of the Level I and II curriculum. The basic dichotomy is whether to have a “hard” divide by developing new courses that run in parallel to our standard courses, or a “soft” divide by introducing enhanced sections of our standard courses. We have discussed the pros and cons and decided to pursue the latter approach for the level I curriculum, inspired by the example of a program currently being run at Simon Fraser University. There are a number of logistical issues that remain to be worked out, for example, how will students be separated between the enhanced and standard sections? We aim to give them freedom of choice while still retaining the flexibility and diversity (especially with respect to gender issues in the sectional divide) of our level one program.

Item 1c. David Lozinski gave a wide-ranging presentation about the many possible ways in which we could enhance the teaching of communication skills in our programs, with special reference to job training and experiential learning. There is recognition that all of these aspects require our attention, and it is also clear that we will need to attend to these issues over the next 3—5 years. For instance, depending on the outcome of the PASF recommendations, it is expected that all students in our programs may need to satisfy a substantial literacy requirement (e.g. 6 to 9 units). Given that, the question is what additional requirements would we like to adopt. At the very least, we plan to designate certain upper year courses as fulfilling the mathematical or statistical communication skills, and to require that all honours students complete at least one such course. We will work to revise the upper year curriculum to ensure that some of the courses include a significant communication component, and we also plan to continue discussing other ways to enhance the teaching of communication skills and to create opportunities for experiential learning for students in our programs.

Item 2a. Engineering has requested that the level 1 engineering math include a greater emphasis on the symbolic computation system MatLab, and this would require the development of new teaching materials in the form of online modules. Engineering has also requested smaller tutorial sizes in the level 1 engineering math classes. It is worth recalling, however, that we made a choice some years ago to put our TA resources into the MathHelp Centre at the expense of running large tutorials. To run both small tutorials and the MathHelp Centre will require increased TA funds. To meet the increased demand, we would propose to revise the undergraduate TA training course Math 2ET3 and hire undergraduate TAs. This change will require additional resources, but we feel the enhanced learning outcomes for the students justify the investment.

Item 3a. We did not discuss the possibility of further collaborations with Business and Social Science during the retreat. We note that we do already have the Actuarial and Financial Math program, which involves students taking many courses in Business, and a large selection of joint honours programs with Social Science and Humanities. We are very open to creating further such opportunities. For example, the Economics department is introducing a direct entry program, and we would be enthusiastic about using this to further the growth of the Economics and Math joint honours.

Dean's Response, Faculty of Science:

The Dean would like to thank the members of the review team for their willingness to participate in the site visit and for preparing the external reviewers report. The Dean would also like to thank the Department of Mathematics and Statistics for preparing the Program response to the review report and also highlight the benefits of the broad Departmental engagement that informed the Program response. The Dean noted that the insightful analysis of the undergraduate programs in mathematics and statistics and the recommendations stemming from that analysis provide a useful roadmap for the Program to follow in the coming years.

The Dean writes that the review report accurately highlights the strengths of the undergraduate programs in Mathematics and Statistics in the Faculty of Science, and in the broader University, as well as the challenges presented by the recent changes in enrollment and the fiscal restraints experienced in the Faculty of Science. The Dean agrees that the increasing student to faculty ratios and the demographics of the faculty complement in the Faculty of Science have presented difficult resourcing decisions for many units, including the Department of Mathematics and Statistics. The Dean notes that the course of action the program has proposed in response to the specific recommendations are appropriate and reasonable; however, there are several areas where she would like to highlight the impact of central Faculty and University initiatives and one area of concern.

Concern:

Recommendation 1b. Offer enhanced version of some level 1 and II courses. While the Dean understands the merits of the recommendation and the desire of the review team to address the concern of some of the students who were interviewed about their request to have a higher degree of difficulty in Level 1 courses, she has some concerns about the Program response to the recommendation. The Dean notes that at McMaster, if courses are considered to be substantially different either in the pre-requisites or in the content, then they must be identified as different courses. As such, any changes would have to be approved at the Departmental, Faculty and University level committees and adhere to the required timelines for those changes. Additionally, the Dean has a larger concern about the experiences of the large number of students who are taking courses that they perceive to be too difficult, rather than not sufficiently challenging, and she would encourage the Program to consider both sides of this recommendation in determining a path forward.

Additional information to supplement Program response:

Recommendation 1c. Expand teaching communication skills. The Dean writes that as identified in the report, this is an area of considerable interest University wide and she would encourage the Program level undergraduate committee to liaise with the central offices responsible for the implementation of the recommendations of the PASF report prior to moving forward with independent action. The Dean would also recommend coordination with the Life Sciences Program in the School of Interdisciplinary Science, who have developed a similar "communications requirement" and "communications course list" for assistance with this action item.

Recommendation 2e. Hire more faculty and also explore blended learning models to leverage technology to compensate for higher student/instructor ratio. The Dean states that in the last budget cycle, two additional appointments of tenure stream faculty members were approved for hire in the Department of Mathematics and Statistics for a July 1, 2019 start. These hires will assist with addressing some of the concerns related to student/instructor ratios.

The Dean noted that the undergraduate programs in mathematics and statistics are an excellent example of the benefits of the reflective process encouraged through the IQAP process. The Program has responded to previous reviews with concrete action and refinement of the programs, and with the additional resources now available due to fiscal changes in the Faculty of Science, will be able to address several additional recommendations.

Quality Assurance Committee Recommendations

McMaster's Quality Assurance Committee (QAC) reviewed the above documentation and the committee recommends that the program should follow the regular course of action with a progress report and subsequent full external cyclical review to be conducted no later than 8 years after the start of the last review.