FINAL ASSESSMENT REPORT

Institutional Quality Assurance Program (IQAP) Review

Statistics M. Sc. Program

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 Statistics M.Sc. Program

In accordance with the Institutional Quality Assurance Process (IQAP), the Department of Mathematics and Statistics submitted a self-study for the Statistics M.Sc. program in December 2017 to the Vice-Provost and Dean of Graduate Studies to initiate the cyclical program review of the program. 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, one from BC and one from Ontario and one internal reviewer were endorsed by the Dean, Faculty of Science, and selected by the Vice-Provost and Dean of Graduate Studies. 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 and Dean of Graduate Studies, Associate Dean of Graduate Studies, 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 Statistics M.Sc.:

- **Strengths**
  - Multidisciplinary nature
  - Quality of students include strong domestic pool
  - Computational statistics

- **Areas for Improvement**
  - 700-level stats course offerings, both in variety and in frequency
  - Courses offered by other departments, which are suitable to students in statistics
  - Multidisciplinary nature of the program
  - Student engagement in the program, and learning and skill development activities
  - Research activities, professional development opportunities, and training programs in the summer

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
1. Developing regular rotation of graduate courses.	The Statistics group plans to return to the practice of holding regular meetings and recommending a slate of courses to the Department. This should help establish a more regular rotation of graduate courses in statistics.	Chair and Associate Chair (Statistics)	Next three years
2. Modernize the curriculum.	A proposal for a new course STATS 790 Statistical Learning is attached. Also, STATS 6CI03: Computational Inference will be offered in Winter 2019 and will be offered on rotation with STATS 6I03: Inference.	Chair and Associate Chair (Statistics)	2018-2019

3. Maintain list of available courses from outside the program.	Regrettably, relatively few students in the Stats MSc program take courses from outside the department. Having an up-to-date list of available courses might serve to increase the participation rate in such courses, and we will consult with other departments to help prepare and maintain such a list.	Chair and Associate Chair (Statistics)	2019-2020
4. Ensure the size of the Statistics group does not decrease.	One new tenure-track faculty hire in Statistics has been approved, with an anticipated start date of July 1, 2019. In addition, candidates in the current search for a teaching-track faculty member in Actuarial Science are expected to be able to contribute through the teaching of undergraduate courses in statistics. Nevertheless, the Stats group is concerned, with the pending retirement of Dr. Roman Viveros, the new hire will only maintain the current supervisory capacity in statistics; additional faculty hires in statistics will be needed to increase that capacity.	Chair	Next five years
5. Hire in modern areas of statistics.	The Department is optimistic that it will be able to recruit a strong candidate working in an area of statistics that will help modernize the program.	Chair, Associate Chair (Statistics), and Appointments Committee	Next two years
6. Improve quality of student office space	The Chair is ultimately responsible for the allocation of all space within the department, including graduate offices. Right now, the department is experiencing a severe shortage of graduate desk space, and the situation will unfortunately get worse before it gets better, since next year a new class of M-Phimac students will all require office space as well. With the Faculty of Science in an improved financial situation, we are hopeful that new space in Hamilton Hall or in a nearby building will be allocated for use by our graduate students.	Chair	Next five years
7. More engagement with students.	Towards the end of each Fall term, an electronic survey will be administered to solicit student feedback.	Chair and Associate Chair (Statistics)	2018-2019

8. Provide Coursework students more experiential learning opportunities.	We plan to investigate potential experiential learning opportunities. Some concrete steps are addressed in response to points **9, 10, 12** below.	Associate Chair (Statistics)	2019-2020
9. Introduce more co-op/internship opportunities	We will continue to make students aware of MITACS, and similar, internships that they may wish to take advantage of. We will also investigate co-op options.	Chair and Associate Chair (Statistics)	Next three years
10. Modify Stats 770.	We are currently working on revamping STATS 770, the seminar course. We plan to submit a new proposal taking into account of all the above suggestions. The new format is expected to take effect in the academic year of 2019-2020.	Associate Chair (Statistics)	2019-2020
11. Increase number of student awards.	At present, the extent to which students are aware of award deadlines depends on who happens to be teaching 400 level courses in the Fall term. Starting in Fall 2018, we will take a more strategic approach and include this information at the start of the third seminar of the Fall semester. Happily, one of our incoming Statistics M.Sc. students received an NSERC-CGS scholarship. Because she is also a graduate of our undergraduate program, this is especially good news.	Chair and Associate Chair (Statistics)	2018-2019
12. Add experiential learning opportunities to graduate courses.	This already happens in part of STATS 780: Data Science and STATS 752: Linear Models and Experiment Designs, where students must complete and present a detailed project on non-trivial data for their final project. A similar approach will be taken with the new course STATS 790: Statistical Learning.	Associate Chair (Statistics)	Implemented
13. Renewal of external faculty involved in supervision within the program.	We intend to actively recruit potential supervisors from other disciplines. Three recent hires from other departments have expressed interests in becoming associate members of the Master's program in statistics. Their names and home departments are: Dr. Youngki Shin (Economics), Dr. Sarmeer Parpia (Oncology), and Dr. Guillaume Paré (Pathology and Molecular Medicine).	Associate Chair (Statistics)	Next three years

14. Review workload of the graduate secretary.	Submit a proposal for a new graduate staff position dedicated to the Departmental graduate programs. Note that we currently have less than one staff person to handle four separate graduate programs.	Chair	2018-2019
15. Governance issues: **(a)** Recognize research supervision outside one's home department. **(b)** Devise equitable ways for faculty to teach courses outside their home departments. **(c)** Provide teaching credit for research supervision. **(d)** Add more Statistics representatives on Appointments Committee.	**15 (a)** This is a good point, and it is a problem that needs to be addressed at the decanal and university level. **(b)** Another good point, one that again requires a solution at the decanal and university level. **(c)** This suggestion has much merit, but presently our faculty resources are stretched thin simply mounting the courses for the program. Additional faculty members in Statistics would make it possible to implement a course-reduction scheme for rewarding graduate supervision. **(d)** The review committee seemed to have been misinformed about departmental governance, and we take a moment to outline the department process for hiring new faculty. The Appointments Committee is an elected committee with one year terms and a two-year term limit. There is a constitutional provision that guarantees representation from at least one member of the Stats group, but there can be (and often are) additional members from the Stats group on the committee. This can occur through the election process, and it also occurs automatically whenever there is a targeted hire in statistics through the following mechanism. In a faculty search, a "hiring subcommittee" is struck, typically consisting of three members appointed by the Chair and working in the area. Such members, if not already elected, are added to the appointments committee for the given search ("add-ons"). The subcommittee is charged with proposing an initial slate of candidates, participating	Chair and Associate Chair (Statistics)	Next five years

	in skype interviews, recommending a short list for on-campus interviews, etc. For example, in a targeted search in statistics, additional members from the Stats group would be selected for the hiring committee. As well, all decisions made by the appointments committee are discussed in an open meeting with all department members invited to participate. Consensus is taken by means of a departmental straw vote, which (if supported) is moved by the appointments committee and formally voted upon. No system is perfect, but ours has the virtue of allowing direct input from all members of the department while also recognizing the expertise of members in the field (e.g. the Stats group), who are better equipped in making decisions on hires in their area.		

Further Summary from the Department:

The Department and Stats group is in general agreement with external reviewers' executive summary:

The master's program in Statistics at McMaster has a history of excellence: attracting high quality applicants; delivering multidisciplinary learning and training; preparing students for highly competitive job market. With the recent addition of faculty specialization in Computational Statistics, the program has been invigourated. However, the program is currently at a crucial stage for meeting key challenges in maintaining/improving the quality of the program: limited number of 700-level Stats courses available to students; limited faculty resources compared to highly increased market demand for qualified statisticians; declined thesis supervision or multidisciplinary engagement by faculty members outside the department.

Research in probability and statistics has been rapidly expanding in the last few years, mainly due to advances in computational technology and the explosive accumulation of data. The new science of big data and machine learning has emerged as an area of significant importance, with its many applications to health, medicine, business and commerce. Data science is also an area of strategic importance to the unit and to the faculty; for instance, it featured prominently as a field of strong interest at the recent Faculty of Science retreat and strategic planning session. The Department of Mathematics and Statistics is well-positioned to take a leadership role in developing training and research programs in big data science, and the faculty members in our unit, especially those working in Probability and Statistics, are well-positioned to make significant contributions to establishing McMaster in this new emerging field.

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. As is cited in the report, data science, and

therefore statistics in all of its various forms, will surely be a foundational part of many advancements at McMaster University in the future and therefore it is very important that we are informed about potential areas for enhancement of this academic program. The Dean would like to also thank the Department of Mathematics and Statistics for preparing the Program response to the review report.

The Dean noted that the reviewers' report highlighted several areas of strength including the "interdisciplinary flavour" of the current Master's Program in Statistics. The Dean applauded the initiative that has been taken to address the current trends in statistics and agreed with the majority of the recommendations presented and their associated action plans. There are a few areas of clarification and updates on progress that the Dean provided to some of the specific recommendations below.

Recommendation 9. Introduce more co-op/internship opportunities. In June of 2018, the budget for the Faculty of Science received approval for a number of new staff positions including a Career Integration Specialist who will be available to assist the Chair and Associate Chair in carrying forward the action plan related to this recommendation. The Career Integration Specialist will assist McMaster undergraduate and graduate students in the Faculty of Science to achieve the highest standard of professional development and career readiness in preparation for life after McMaster. The Career Integration Specialist will work closely with academic departments, career centre and student services staff, student groups, and other campus stakeholders to develop, implement and evaluate programs that embed career learning and development into curricular, co-curricular and extracurricular activities.

Recommendation 11. Increase number of student awards. The Associate Dean (Graduate) for the Faculty of Science has been directing a comprehensive review of graduate funding models in all programs in the Faculty of Science and that review is now ready for distribution to all programs. In agreement with the observations of the review team, the graduate programs in the Department of Mathematics and Statistics have some of the highest supervisor contribution rates, and highest percentage of international students along with some of the lowest percentage of students with external scholarship support. These data support the plans to increase efforts in terms of scholarship support for graduate students, increase the quality of the domestic students admitted to the program and continue to attract high quality international students. The comparison funding models used in other graduate programs in the Faculty of Science may also provide some insight in terms of alternative funding models for consideration by the program.

Recommendation 14. Review workload of the graduate secretary. The Dean agreed with this assessment in terms of the need for more administrative resources for the graduate programs in Mathematics and Statistics and, as such, has recently approved additional administrative staffing for this unit. There is also considerable effort being placed on improvements to the tools available to graduate administrators (MOSAIC) throughout campus.

Recommendation 15. Governance issues. (a) Recognize research supervision outside one's home department. The Dean was puzzled by both the review team recommendation and the Program response to this item. There are, the dean believes, two main ways in which research supervision conducted by faculty members is recognized at McMaster university and both allow for equal levels of recognition regardless of alignment of the "home" department of the student and the faculty member. In both the career, progress and merit scheme (CPM) and the tenure and promotion processes (T&P), faculty members are encouraged to identify all student supervision activities and research activities in all Departments and Faculties, and even outside of McMaster, and there is no indication or practice the Dean is aware of that prioritizes one category of activity above another.

Recommendation 15. Governance issues. (b) Devise equitable ways for faculty to teach courses outside their home departments. Similar to the Dean's response to item 15(a) above, there are currently mechanisms in place for cross-Department and cross-Faculty teaching. While many of these arrangements exist at the undergraduate level, the Faculty has also supported those activities at the graduate level in the past. There has been a period of considerable adjustment to the implementation of the current budget model at McMaster and to the impact on budget allocation practices within the Faculty of Science. The Dean is open to all proposals that support the academic goals and strategic plans of each unit and academic program, including the support of interdisciplinary activities at both the undergraduate and graduate level, and will work with the Department of Mathematics and Statistics to ensure that they are aware of models for implementing this type of collaborative activity.

Overall it will be important for the Department of Mathematics and Statistics to balance the increasing demands for resources and opportunities in the areas of Statistics and Data Science, with the need to maintain their excellence in fundamental mathematics. While the Dean agreed that the Faculty of Science should support continued investment in this program, it must certainly be balanced by the Faculty's needs to invest in many other areas in Science. As such the fostering of the interdisciplinary connections and activities of this program, and the new PhD program in statistics, will be essential in the future.

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.