

Final Assessment Report

Statistics & Actuarial Science and Quantitative Finance, (MActSc, MMath and PhD in Actuarial Science, PhD in Statistics-Biostatistics, MMath and PhD in Statistics, MQF in Quantitative Finance)

August 2018

Summary of the Program Review:

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 MActSc, MMath and PhD programs delivered by the Department of Statistics and Actuarial Science. A self-study (Volume I) was submitted to the Associate Provost, Graduate Studies Office on November 17, 2015. The self-study presented the program descriptions and learning outcomes, an analytical assessment of these eight programs, and program data including the data collected from a student survey along with the standard data package prepared by the Office of Institutional Analysis & Planning (IAP). Appended were the course outlines for all courses in the program and the CVs (Volume II) for each full-time faculty member in the Department.

Two arm's-length external reviewers (Volume III), (Dr. Louis-Paul Rivest, Professor of Mathematics and Statistics, Université Laval and Dr. Emiliano A. Valdez, Professor of Actuarial Science, University of Connecticut) were ranked by the Associate Provost, Graduate Studies, in addition one internal reviewer (Dr. Marc Aucoin, Assistant Professor of Chemical Engineering) was selected by the Associate Provost, Graduate Office.

They reviewed the self-study documentation and then conducted a site visit to the University on April 14-15, 2016. The visit included interviews with the Associate Provost, Graduate Studies; Dean of Mathematics; Math Associate Dean of Graduate Studies, Chairs and Directors of the programs, Graduate Officers, Faculty members, staff and meetings with a group of current graduate students.

This final assessment report is based on information extracted, in many cases verbatim, from the self-study, the external reviewers' report and the program response.

Program characteristics:

The Department of Statistics and Actuarial Science is one of four departments in the Faculty of Mathematics, which also contains the School of Computer Science. It was created as the Department of Statistics in 1967 when the Faculty was formed. The name was changed in 1982 to recognize the substantial contribution of Actuarial Science to the Department and Faculty.

All of the MMath programs (Actuarial Science, Biostatistics and Statistics) in the Department have two objectives:

- To deliver an intensive advanced level study of the corresponding subject area;
- To give students a significant, if brief, introduction to research.

The Master of Quantitative Finance (MQF) focuses on the fundamental disciplines of mathematics, statistics, econometrics, computer science and finance. It provides students with the analytics tools to solve practical problems in the complex and rapidly evolving financial industry.

The Master of Actuarial Science (MActSc) is a professional program, designed to recruit highly qualified students with strong quantitative and communication skills (but not extensive actuarial science training). The aim of the program is to offer the finest professional post-graduate education in actuarial science and practice in the world and to develop both technical and business skills in the context of the modern risk management environment. The program has been accredited by the Canadian Institute of Actuaries (CIA) and the Institute of Actuaries in the United Kingdom.

The objective of all three PhD programs (Actuarial Science, Statistics and Statistics-Biostatistics) is to prepare candidates for a career in teaching and research. Graduates are expected to have acquired autonomy in conducting research and preparing scholarly publications.

Summary of strengths, challenges and weaknesses based on self-study:**Statistics MMath and PhD Programs****Strengths**

- Breadth and size
- Large offering of courses, in a reasonably wide range of applied and research topics
- Employability of graduates

- Supportive Department with a lot of activity (such as weekly seminars)
- Prominent researchers
- MMath is particularly strong due to Waterloo undergraduates entering the program
- MMath is only one year long and offers generous funding
- Very strong retention of students

Weaknesses

- PhD funding is relatively poor
- Difficulty competing with top US schools due to their reputation
- Large class sizes
- Lack of available computational support
- PhD, Master and undergraduate students in the same classes

Threats

- Competition from other Canadian schools; University of Alberta offering more funding
- Lack of diversity in graduate student population
- Size of cross-listed courses (too many undergraduate students)
- Data analytics now done by other disciplines
- Very dependent on a single staff member

Actuarial Science MMath and PhD Programs

Strengths

- Masters and PhD students well-regarded internationally
- Faculty world leaders in Actuarial Science research
- Good student support and strong professional ties
- Option to integrate actuarial science with finance and risk management due to vast course offering of finance course
- Students able to develop strong technical skills from a diverse set of courses

Weaknesses

- Lack of domestic students and an overreliance on international students from China
- Inability of students to communicate technical ideas at both Masters and PhD levels
- Undergraduate students enrolled in graduate courses
- Inability to cover other areas such as economics, business organization, accounting

Threats

- Actuarial science could disappear as a discipline
- Competition from Asian universities
- Difficult to recruit very strong students due to competition from other universities
- Employment rates, particularly of international students
 - Some students not ready, lack of developed communication skills
 - Supply of graduates higher than demand

Masters of Quantitative Finance (MQF)**Strengths**

- Very strong computational skills of graduates
- Strong employment rates
- Established reputation of program
- Co-op opportunities for students
- Stringent admission requirements including technical and non-technical questions
- Small cohort size and reasonable tuition
- More rigorous than most similar programs

Weaknesses

- Some students lack broad knowledge of finance
- Use of thesis option (some students use it in order to avoid more difficult courses)
- Students enrolled in same courses as other graduate students within the Department
- Narrow program and do not develop case studies

Threats

- Difficult to hire within Statistics and Actuarial Science Department
- Difficult to compete for faculty talent with industry and business schools (particularly because of lower salaries)

MActSc Program**Strengths**

- Strong international reputation of program, faculty and school
- Strong students
- Unique in North America; only one of a few such programs

- Small class size and integration of quantitative, communication skills and real-world application
- Strong industry ties

Weaknesses

- No internship opportunities
- No financial support for students; best students are offered funding from competitors
- Lack of flexibility; students must take all courses and are unable to specialize

Threats

- Weak job market
- Other universities may set up similar program
- Tightening immigration requirements
- UK program offering more than Waterloo is offering
Difficult maintaining industry relationships

Summary of key findings from the external reviewers:

The external reviewers found that PhD programs in the Department provide a nice balance between foundational issues and modern applications and that the graduates are well prepared to pursue a career in academia. They also highlighted research and teaching opportunities available to students and noted that such opportunities are not typical at other institutions. The reviewers noted that faculty members in the Department and those involved with all the graduate programs are truly exceptional.

Each of the MMath programs (Actuarial Science, Biostatistics and Statistics) provide a breadth of foundation courses in each discipline as well as an introductory opportunity for students to conduct first-hand research through the completion of either a research paper or thesis. The scope of these programs is wide enough to accommodate students who either want to pursue PhD studies, or find jobs in the industry or the public sector once their degree is completed. They have also noted that the Department is best in Canada for both, training in statistics and in actuarial sciences.

Program response to external reviewer recommendations:

Recommendations

1. *An exit survey to get students' feedbacks on the program they had just completed. For the professional programs (MQF and MActSc) this is implemented informally as alumni are*

involved in training and in mentoring the students. It might be useful in the other programs, especially the MMath programs.

Response

The program plans to implement this for all Masters programs. They believe that this information is already available for PhD graduates due to close links between students and their supervisors.

- 2. A more rigorous evaluation of the students who are candidates for the PhD program could be envisaged. This could be done by conducting a phone interview with top candidates. This would help to ascertain their communication skills; it could also provide an opportunity to promote Waterloo programs to outstanding students.*

Response

PhD students are screened by the Associate Chair for graduate studies based on their written applications. Information about the PhD candidates who pass this screening is posted for all faculty members to see and review. PhD students are then only admitted on the recommendation of a supervisor. As part of this process, potential supervisors are strongly encouraged to conduct a phone interview of the candidates and the Department feels that they are already meeting this recommendation. However, the Department will consider the possibility of extending a phone interview to students applying to the MMath programs as they are already part of the MActSc and MQF admissions process.

- 3. An internship in a neighboring insurance company would benefit the students in this program. This program is already highly structured and, in informal discussions, many obstacles to the implementation of this proposal were mentioned.*

Response

The Department has been considering, for a while, adding an internship to the MActSc program. This suggestion was also made by the program's advisory board consisting of industry partners. The difficulty lies in implementing the internship as the program is very demanding, with 5 courses per term and adding an internship parallel with an existing academic term is not feasible from a time commitment perspective. Adding an internship after two terms would result in some logistical difficulties as there would be a double cohort present on campus at the same time. Additionally, since the program is designed to take strong students with little or no actuarial science background, the Department feels that they require all three academic terms to learn the background and skills needed to work in the insurance industry at the level desired by the Department. Adding one at the end is a possibility but current graduates secure

employment within a few months of graduation and adding an internship at the end would lessen the usefulness of it.

- 4. Teaching assistantships (TAs) are a way to fund students who are then expected to fulfill their duties diligently. TA evaluations could be improved and their results should be communicated to the TAs. Clear messages need to be sent to TAs whose work is below expectations. The Department has a TA award; the selection criteria for this award should be communicated to the graduate students. Some students believe there is lack of transparency in the selection process.*

Response

The Department assembled an ad hoc committee consisting of faculty, lecturers, a graduate student and an undergraduate student to consider this issue and the roles and expectations of TAs more generally. This committee provided detailed recommendations in a report dated August 2016. The Department implemented the suggestions in the report starting in Fall 2016. Some specific suggestions included a mandatory TA training session that focuses on how to successfully run tutorials (among other topics) and a requirement for instructors to provide information at the start of term of the expectations (including a rough estimate of timing) for each TA. The committee also produced two summary documents that were approved by the department. One has the title “TA Roles and Responsibilities” and the other has the title “Working with TAs”. At the university level there is also ongoing work on updating the TA policy. Once this policy update is available, we will ensure our current practices related to TAs meet university policy.

- 5. Sessional lecturers, especially those teaching for the first time, should have a faculty mentor. The mentor could help with the content of the course material and the exams. In large courses involving TAs, the mentor could also be involved in TA supervision. Both sessional lecturers and TAs are graduate students; it might therefore be difficult for a sessional lecturer to reprimand TAs whose work is not adequate. The mentor could help with TA supervision.*

Response

The Department implemented this recommendation in the Fall 2016. Documentation on teaching issues that are normally provided to new faculty hires will from now on also be provided to new sessional instructors. In addition to this, the Faculty of Mathematics has a Teaching Fellow who has also been active in engaging sessional instructors in various learning/training activities. These activities are often supported by the Centre for Teaching Excellence.

- 6. Mentoring is important to facilitate the integration of new faculty and to introduce them to the Waterloo tradition. This may be best accomplished by pairing them with an experienced faculty for a joint task force, say the teaching or a two-sections service course. Their integration might be facilitated by having them involved with academic committees managing the programs of the Department. They might also be given the opportunity to present their research results in a Departmental seminar, without the stress of a job interview.*

Response

The Department has a formal mentoring program for new faculty that they believe works well. Each new faculty member is assigned a mentor who is a more senior member of the Department, usually active in a similar research area and from a similar background (e.g. both the mentor and the mentee originate from China). Both individuals are provided with resource material that describes the mentoring process. New faculty are usually the junior partner in teaching a multiple section course in their first few terms in Waterloo. Young (pre-tenure) faculty are also assigned carefully selected service duties to help them acclimatize to the processes in the department, faculty and university. In addition, all young faculty are encouraged to give another research seminar in the regular Department seminar series or the graduate students' seminar series.

- 7. How to define a good lecturer is not easy. They might be interested in pedagogical innovations and their implementation in the classroom. If this is so they should be given opportunities to foster their pedagogical skills and to implement innovations in the classroom, in agreement with the objectives of the program managing the course.*

Response

The Math faculty has been proactive in addressing the needs of the growing number of teaching faculty. Recently, a new faculty committee has been addressing the questions of lecturer titles, expectations, promotion requirements/rules, etc. This is an ongoing process. Existing lecturers are encouraged to develop their knowledge and teaching methods. Some of the lecturers have attended teaching related conferences to present ideas and have been provided funding to do so. The Math faculty also has a Teaching Fellow, selected from among the regular faculty members, whose role is to encourage innovation, celebrate excellent teaching and work one-on-one with anyone in need of improvement. Until June 30, 2016 the teaching fellow was Cynthia Struthers a faculty member from the Statistics and Actuarial Science Department and as of July 1, 2016 the new faculty Teaching Fellow is Brian Forrest from the Pure Math Department. The Teaching Fellow organizes many events throughout the year to highlight teaching and encourage a sharing of experiences and best practices. This includes, for

example, a session every fall term where some strong experienced instructors give a sample lecture and all new instructors give short mock lectures and are given feedback.

8. *We were impressed by the diversity of graduate students. We met students from at least five different countries, including China. For the time being, lack of diversification does not seem to be an issue for the department. Aiming for quality and putting in place rigorous mechanisms for the selection of graduate students, regardless of the country of origin, is the way to go.*

Response

The Department will continue to admit best students who apply to their graduate programs, but is nonetheless committed to making Waterloo a more attractive destination for students from non-traditional countries.

9. *The new Canadian Statistical Science Institute (CANSSI) offers many opportunities for International collaborations and for networking. The Department could explore ways of becoming involved with CANSSI. It is three years old and between 6 and 9 collaborative research teams have been funded by this new program. For the time being, Waterloo involvement appears to be limited.*

Response

The Department states that Waterloo has been involved with a number of CANSSI sponsored activities (though not the collaborative research teams) including hosting a number of CANSSI supported conferences and workshops recently. In addition, CANSSI is currently considering the possibility of selecting a permanent home for the institute. Waterloo with its large Statistics and Actuarial Science Department and general strength in mathematics would be a natural fit. The faculty plans to put together a proposal to make this happen.

Implementation Plan:

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	Exit survey of graduate students	Implement proposal for all MMath graduates	Carlos Mendes	Complete (started Fall 2016)
2.	Phone interviews of possible PhD students	Already done for the most part, will strongly encourage potential supervisors to do this	Associate Chair Graduate Studies	Complete
3.	Internship in MActSc programs	Not feasible at this time	n/a	n/a
4.	Improve communication of expectations to teaching assistants	Implement recommendation	Associate Chair Graduate Studies	Complete (department committee report August 2016 – suggestions implemented starting Fall 2016)
5.	Teaching mentors for new sessional instructors	Implement recommendation	Associate Chairs Actuarial Science and Undergraduate Studies	Complete (started Spring 2016)
6.	Enhanced mentoring of new faculty	Already in place	n/a	n/a

7.	Lecturer engagement	Partial in place already, faculty committee is currently looking into this issue	Diana Skrzydlo, Department Faculty Mentor and Development Coordinator	Complete. Engagement activities (including regular informative sessions) started Winter 2017
8.	Strategic graduate student recruitment	Continue to admit the best students available	Associate Chair Graduate Studies	Ongoing
9.	Improve connections with CANSSI	Explore possibility of becoming the permanent home for CANSSI	Stefan Steiner, Chair	We were not selected as the new permanent home for CANSSI. Individual faculty members are engaging with CANSSI activities on an ongoing basis.

The Department Chair/Director, in consultation with the Dean of the Faculty shall be responsible for monitoring the Implementation Plan.



Date of next program review: _____ 2022

Date

Signatures of Approval:

Stephen Hsu

January 24, 2018

Chair/Director

Date

AFIW Administrative Dean/Head (For AFIW programs only)

Date

SM

2018-01-25

Faculty Dean

Date

Associate Vice-President, Academic

(For undergraduate and augmented programs)

Date

Jeffrey M. Cuello

August 28, 2018

Associate Provost, Graduate Studies

(For Graduate and augmented programs)

Date