

Final Assessment Report

Bachelor of Mathematics in Statistics, Statistics for Health, Actuarial Science, or Mathematical Finance (BMath)

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 arm's length external evaluation and the internal response and assessments of the Statistics, Statistics in Health, Actuarial Science and Mathematical Finance Bachelor of Mathematics (BMath) programs delivered under the Department of Statistics and Actuarial Science. The Self-Study Volume I, was provided electronically via a SharePoint website, to the Associate Vice-President, Academic and Quality Assurance staff in June 2016. Self-Study Volume I included a program description, learning outcomes, and an analytical assessment of the program, as well as student surveys and the standard data package prepared by the Office of Institutional Analysis & Planning (IAP). Volume II of the Self-Study contained the CVs for full-time tenured and tenure-track positions and continuing lecturers affiliated with the program.

Two arm's-length external reviewers were selected by the Associate Vice-President, Academic: Professor and Chair, Michael Daniels (Department of Statistics and Data Sciences, University of Texas at Austin), and Professor of Actuarial Science, Emiliano A. Valdez (Department of Mathematics, University of Connecticut). Professor Colin MacLeod (Department of Psychology) served as the University's internal reviewer during the site visit.

The site visit occurred on August 9-10th, 2016 and included interviews with the Associate Vice-President, Academic; Associate Dean, Undergraduate Studies in Math; Chair of the Department of Statistics and Actuarial Science; the Associate Chair Undergraduate and the Associate Chair Actuarial Science of the Department of Statistics and Actuarial Science; various faculty members and a group of current 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 began as the Department of Statistics in 1967, when the Faculty of Mathematics was formed – later the name was changed to recognize the substantial contribution of Actuarial Science to the Department and Faculty. A co-op stream in Mathematics was initiated in 1964 at the behest of local insurance industry leaders, and many students in actuarial science and statistics took advantage of this option. In terms of the number of statisticians and/or actuaries, the Department is the largest in Canada, and one of the largest in North America. As of May 2014, the department had 39 tenured or tenure-track faculty members, 2 definite term professors and 9 lecturers.

The following undergraduate degrees are available in the Statistics and Actuarial Science department (all lead to an honours degree and are offered as either coop or regular):

- Bachelor of Mathematics in Statistics
- Bachelor of Mathematics in Statistics for Health
- Bachelor of Mathematics in Actuarial Science
- Bachelor of Mathematics in Mathematical Finance (joint with the Department of Pure Mathematics)

There is also the option to take a Minor in Statistics or Actuarial Science.

Summary of strengths, challenges and weaknesses based on Self-Study:**Strengths**

- Graduates are well-regarded internationally
- Students develop strong technical skills from a diverse set of courses
- Faculty are world leaders in Actuarial Science
- Program has strong professional ties
- Many textbooks used in our courses and at other universities were written here
- Integration of actuarial science with finance and risk management allows students a variety of finance courses
- Over 90% of Waterloo Math graduates are either satisfied or very satisfied with the credential they earned at university (National Graduate Outcome Survey - NGOS)

Challenges

- In the future, international undergraduate students may decide to instead go to top Asian universities and in particular the best Chinese universities who are improving quickly
- How to stay as the top Actuarial Science school in North America (and the world!)
- Difficult to hire/recruit new faculty

Weaknesses

- Very large class sizes, e.g. including 4th year courses with over 100 students
- The actuarial science program is strong, but there are some gaps (e.g., property and casualty insurance and pensions – there is reliance on sessional instructors to teach these courses)
- Low enrolment in the Statistics for Health plan
- The programs do not have the time, space and faculty to cover/teach other areas (e.g., economics, business organization, financial management, accounting)

Summary of key findings from the external reviewers:

In summary, the reviewers found all four programs to be very impressive in delivering quality education to top caliber students and producing graduates who are in high demand. Common strengths among all programs included outstanding leadership, faculty members, administrative support, and students. The programs provide the necessary breadth of foundational courses to help students prepare for many careers in industry, as well as those intending to do advanced studies. The co-op program, which provides students gainful practical industry experience, was viewed as very impressive with strong positive endorsements from both students and employers.

Program response to external reviewer recommendations:

Recommendations

1. **Large Class Sizes:** This is a result of the increased popularity (which is a good thing) of the programs and courses. However, this inhibits the optimal learning experience in these programs as the large class sizes make it very difficult, if not impossible, for the students to do projects (and an appropriate amount of applied work), which is an essential part of these programs and helps to solidify the theoretical and methodological knowledge gained from the courses. The only solution we can see to reducing class size – particularly critical at the fourth-year level – is the hiring of additional tenure-stream faculty and lecturers. In so doing, the balance of these two will be important to keep in mind: It seemed fairly reasonable at present with 41 tenure-stream faculty and 9 lecturers.

Response:

This is a challenging problem that we are well aware of and trying to address. As suggested by the reviewers, assuming our courses remain popular, the only solution is to hire more faculty. The issue has been acknowledged by the Dean and in 2017 we had permission to hire four tenure-stream faculty and three lecturers. Of these tenure-stream faculty, three are new positions. In addition, we had permission to hire up to two more tenure-stream faculty

bridging to two agreed upon retirements in 2018. All three lecturer positions are new. While this is only a first step it is a very positive development that we hope will continue in future years. However, to accommodate our growing numbers of students and to be able to reduce class sizes to an reasonable level, additional faculty will have to be hired in the coming years.

2. Space Implications: As is common with many universities, space is limited and a valued commodity. The Department of Statistics and Actuarial Science is practically out of space. Given further expected growth, which is essential to the well-being of each program (and is currently planned), future space needs will have to be addressed urgently. These include both office space for new faculty members and suitably-sized classroom space.

Response:

Space constraints are definitely a growing concern especially with our growth plans as described in response to point #1 above and other initiatives such as our new undergraduate and Masters Data Science programs. We are close to filling our available space in the M3 building. In 2016 and 2017 we moved some student club offices, and renovated and repropoed a couple of underutilized rooms to create new faculty/staff offices. This will cover our needs for 2018 and early 2019. In the future, there are preliminary plans for a fourth Mathematics building. Hopefully ground breaking will take place in 2019 or 2020, but the plan has not been approved by the Provost. A new building is greatly needed to accommodate expansion in the faculty in general and for our department in particular. In the shorter term, the Faculty of Mathematics is exploring the idea of renting space off campus to house some of the Faculty activities. This will hopefully free up some space for the Department of Stats and Actuarial Science, although it is unclear how much space this will free up.

3. Re-evaluate the goals and mission of the Bachelor of Mathematics in Statistics for Health. It would be good to reassess the currently under-enrolled program in Statistics for Health. The current emphasis is on healthcare systems and includes numerous business courses. A more popular emphasis might be to frame it as more of a 'biostatistics' program with standard statistics courses, specific methodological courses for health data (e.g., courses on analysis of survival and longitudinal data), a few public health courses (e.g., epidemiology), and maybe one or two 'biology' courses. This recommended change in program emphasis may help with the low enrollment and should not require the introduction of many (if any) courses. Many (if not all) of these needed courses are already in place and being offered by the department. Attention should also be given to the number of required courses, since presently that number is large.

Response:

We agree with this assessment concerning the Statistics for Health program. Despite the

popularity of some of the technical courses designed for this program there are few students actually enrolled in the program (we had only 30 students enrolled in the plan in 2016 and in 2016 only 2 students graduated from the program). Starting Fall 2018 the program has been renamed Biostatistics. The new version of the program has a better title that is a well established discipline and has a more focused set of required courses that we believe will appeal to our existing students.

4. Exit and Follow-Up Survey for Graduates: A powerful way to market programs is to 'advertise' successful student placements, whether it be attractive positions in industry or enrollment in top graduate programs. The current tracking and monitoring of graduating students appears inadequate. Implementation of a formal exit survey would be a good start. Such a survey might collect information on: student satisfaction with the program, ways in which the program might get even better, plans for after graduation (i.e., job position, graduate school enrollment), and sustainable contact information. The latter pieces of information could be kept in a database and updated going forward. This will have the dual benefits of 'advertising' the success of the graduates for these programs, which will help the continued recruitment of top students, and for development, including identification of donors for endowed fellowships, chairs, etc.

Response:

A similar suggestion was made in our recent graduate program review. As a result, we had already developed a draft exit survey for graduate students that we have now also adapt for undergraduate students. Since April 2017 we have asked all graduating students to complete an exit survey.

5. Introduce Capstone Courses for All Programs: Capstone courses would be an important and attractive addition to all three programs to partially offset the problem caused by large advanced undergraduate courses and to provide an important project-based (case study) course in a small class size setting. We do understand, however, that to undertake this initiative, additional faculty would need to be hired or a reallocation of current resources would be required given the large numbers of fourth-year students across the programs.

Response:

As mentioned in our self-study, we already planned to offer a capstone course for our best 4th year Actuarial Science students in Winter 2017. This new course is taught using a case study format and focus on practical issues and communication skills. We are keen to offer a similar capstone course for Statistics students and Mathematical Finance students. However, the main constraint here, as pointed out by the reviewers, is the lack of resources, especially when many of our other 4th year courses often have enrolments of over 100 students. We

believe enrolment in a capstone course should be limited to at most 20-25 students. We do not have a time line for offering additional capstone courses, but hope to do so if and when teaching resources allow. We are also still exploring other possible formats for a capstone course including something where students are responsible for selecting their own projects.

6. Career Paths for Lecturers: In discussion with a subset of the lecturers, it was apparent that they feel that the process for promotion from a term-to-term hire to a permanent continuing position is unclear. Further orientation and support from the administration of the department for the lecturers on this issue would help to alleviate career tension for the lecturers currently on a term-to-term basis. A model such as an initial 2-year appointment, a subsequent 3-4-year appointment, and then promotion to Continuing Lecturer would be worth exploring. Some consideration of reduced teaching when preparing new courses would also be worth discussing.

Response:

We agree that lecturers are critical to the success of our department. The identified issue of unclear career paths for lecturers is acknowledged at all levels at the University of Waterloo. At the university level, a committee has been looking at Policy 76 - Faculty Appointments, but it is unclear when they will propose a change to the policy. At the faculty level, there is a special committee tasked with recommending new faculty wide guidelines for lecturers that will hopefully clarify the role of lecturers and their possible career paths.

7. Consider Hiring Waterloo Actuarial Science PhDs: For the Actuarial Science program, hiring top faculty is challenging given the small number of strong Actuarial Science graduate programs in existence. On top of this, many of the top PhDs come from the graduate program at Waterloo. The policy of not hiring one's own graduates, which in general is a good policy, may restrict the necessary growth and maintenance of strength of the Actuarial Science program going forward.

Response:

It is challenging hiring in the area of Actuarial Science. The field is relatively small and PhD graduates have good career prospects in industry. Our current practice prohibits hiring our own PhD students in either Statistics or Actuarial Science unless they have been away for at least two years. This is consistent with university guidelines as provided by the Provost. So, we are able to hire our own graduates but only after they have been away for some time. We feel this is a good policy both for us and for our graduating students who benefit from seeing how things are done at other universities. In the past, considering our own students immediately after graduation has caused internal divisions that took a long time to heal. In addition, since this hiring practice has been in effect, we have made some excellent hires.

8. Increase Diversity in Enrolments: International students are predominantly from China. To increase diversity and to reduce the risk of that one market diminishing, it will be important to tap other markets (e.g., the Indian subcontinent). The department should explore the best options to do this. For example, there may be opportunities to leverage current university programs/partnerships to target potential students from other countries.

Response:

The Math faculty is acutely aware of our lack of diversity in international students and actively recruits in a number of countries around the world. Hopefully, in the future, our recruitment in other countries will be more effective. The Statistics and Actuarial Science department does not directly control admission into our programs since they are all second year entry. All our students apply to the Honours Mathematics program at the University of Waterloo. Only after they have proven their ability in first year can they enroll as a major in one of our programs. As such, we have much less control over recruitment than some other Math faculty programs. One example of how the department has contributed to our goal of increasing our international diversity is provided by our actuarial science development project in Indonesia funded primarily by Global Affairs Canada. Through this project we have done considerable mathematics and actuarial science outreach work in Indonesia. This activity has considerably increased the profile of the University of Waterloo in Indonesia and may in future contribute to an increase in the number of Waterloo students from Indonesia.

Implementation Plan:

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	Reduce class sizes, particularly in fourth year courses	In 2016 and 2017 we were able to hire 5 new tenure-track faculty and 3 new lecturers. Plans for 2018 have not yet been finalized.	Chair	Ongoing. Due to increases in student enrolments in our programs, our new Data Science program, some retirements/faculty departures and budgetary constraints we still struggle with large class sizes
2.	Address future space needs (i.e., office space for new hires and suitably sized classroom space)	New fourth Math (M4) building proposed/ Renting space off campus	Dean	Ongoing. The Math Faculty is activity fund raising to make M4 a reality. In the short term they are exploring renting space off campus.

3.	Reevaluate the goals of the Statistics for Health program	A subcommittee of faculty who teach the relevant courses has been struck to review program and required courses	Steve Drekcic, Assoc. Chair Undergraduate Studies	Done. Program changes approved in time for Fall 2018
4.	Design and implement exit survey for our graduating students	implement recommendation	Carlos Mendes, Administrative Officer SAS	Done. All graduating students since April 2017 are asked to complete an exit survey.
5.	Introduce capstone courses	Develop and offer capstone course for actuarial science students	Christiane Lemieux, Assoc. Chair Actuarial Science	Partially complete. Every Winter term since 2017 we have offered a capstone style course for our best actuarial science students. With current teaching resources we are unable to implement this recommendation for our other students at this time.
6.	Further career path orientation and support from the administration of the program for lectures	Wait for University level committee looking into	Chair ,	Ongoing. We now have an informal policy in the Mathematics faculty to

		this issue to provide guidance	Carlos Mendes, Administrative Officer SAS	provide long term (and newly hired promising) lecturers a clearer path to continuing lecturer status. This includes offering 3 year contracts and the expectation that after 2 such contracts they will be considered for continuing status. We can't adopt official policies until the University level committee finishes its work.
7.	Consider hiring Waterloo Actuarial Science PhDs (Current university policy prohibits hiring our own PhD students in either Statistics or Actuarial Science unless they have been away for at least two years)	Approach Waterloo Actuarial Science PhDs two years past graduation	Chair	Not completed. We feel this is not in our best interests.
8.	Increase diversity in enrollments (Statistics and Actuarial Science does not directly control admission into their programs since they are all second year entry. All students apply to the Honours Mathematics program at the University of Waterloo. Only after they have proven their ability	Continue outreach and recruiting activities in different parts of the world, including a new emphasis on India	Mathematics Faculty Assoc. Dean Admissions and Outreach, Troy Vasiga	Ongoing.

	in first year can they enroll as a major in one of our programs)			
--	--	--	--	--

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



2022

Date of next program review:

Date

Signatures of Approval:

Steph Aheo

Jan 5/18

Chair/Director

Date

AFIW Administrative Dean/Head (For AFIW programs only)

Date

SON

2018-01-08

Faculty Dean

Date

Yannis Criglis

August 20, 2018

Associate Vice-President, Academic
(For undergraduate and augmented programs)

Date

Associate Provost, Graduate Studies
(For graduate and augmented programs)

Date