

Final Assessment Report

Pure Math (MMath/PhD)

June 2017

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 programs (BA, MA, PhD) delivered by the Department of Mathematics. A self-study (Volume I) was submitted to the Associate Provost, Graduate Studies¹ on June 12, 2015. The self-study presented the program descriptions and learning outcomes, an analytical assessment of this program, 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. Karl Dilcher, Professor of Mathematics, Dalhousie University and Dr. James Mingo, Professor of Mathematics, Queen's University, were ranked and selected by the Associate Provost, Graduate Studies, in addition one internal reviewer (Dr. Larry Swatuk, Associate Professor of Environment).

They reviewed the self-study documentation and then conducted a site visit to the University on March 28-29, 2016. The visit included interviews with the Vice-President, Academic & Provost; Associate Provost, Graduate Studies; Dean of the Faculty; Faculty Associate Dean of Graduate Studies, Chair of the Department, 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 Pure Mathematics (Pure Math) began in 1967 as one of the five departments in the newly created Faculty of Mathematics. The objective of the MMath in Pure Mathematics program is to develop and enhance students' mathematical knowledge and independent learning skills. This is done by deepening and broadening their mathematical understanding, and by

¹ The Associate Provost, Graduate Studies title changed to Associate Vice-President, Graduate Studies and Postdoctoral Affairs as of June 2017.
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guiding them through the process of independently exploring a specialized mathematical topic at a deep level and communicating their findings to others.

The objective of the PhD program is to develop independent research mathematicians who are prepared for a career in academia at an institution for higher learning. Students are required to attain substantial breadth and depth of knowledge and understanding of mathematics, as well as advancing the state of knowledge by carrying out original, independent, publishable research.

Summary of strengths, challenges and opportunities based on self-study:

Strengths

- The program has internationally renowned researchers who have strong mentorships with students
- The program features outstanding research groups with a focus on algebra/logic and geometry/topology as well as exceptional strength in functional analysis and number theory
- Pure MMath graduates have a high level of employability and many go on to pursue a PhD
- PhD graduates are also very successful in obtaining good postdoctoral positions
- The program is recognized within the Faculty of Math to have outstanding and dedicated teachers and supervisors
- The Pure Math Department is known to have a very collegial, collaborative atmosphere
- Graduate students in Pure Math have been very successful in winning NSERC awards in addition to prestigious Trillium awards
- The level of program funding is competitive making it attractive for Canadian and Permanent Residents

Challenges

- Due to small size of the Pure Math Department they are unable to offer a large number and variety of courses as compared with larger departments

- The Department's NSERC Discovery Grants are used to capacity and cannot accommodate further growth (e.g., provide more postdoctoral positions)
- Pure Math would like to improve funding for international students to make it comparable to students who are Canadian or Permanent Residents
- The program finds the current NSERC scholarship model frustrating as it seems to put emphasis on publications rather than depth of training

Opportunities

- The program has the workload capacity to supervise more postdoctoral fellows, but not the funds to support more positions
- Pure Math would like to provide better teacher-training opportunities for students. A mentoring system is in place for those teaching their own courses; however, they would like to provide this opportunity for senior students wanting an academic career
- The Waterloo 'brand' in mathematics is very strong at the undergraduate level. This could be used to build the strongest PhD program in Canada and one that would rival the top programs in the United States

Summary of key findings from the external reviewers:

The Department of Pure Mathematics offers high-quality graduate programs at the Master's and PhD levels. These programs are well administered and have been well received by students and alumni, with very good measurable outcomes.

The quality of graduate supervision is very high, and supervisors are approachable and available. In interviews, faculty expressed the importance of good supervision, while students showed a great degree of satisfaction with the level of supervision.

In summary, the reviewers had no doubt that the current quality of the graduate programs can and will be maintained in the future. In fact, they see the potential of these program rising to the very top among comparable programs, thus matching the reputation and quality of the undergraduate mathematics program.

Program response to external reviewer recommendations:**Recommendations**

1. “We recommend that the Department not offer a direct entry to the PhD program without a MMath (or equivalent) degree.”

Response

This is the current practice of the Department. As recommended by the Reviewers, the Department will continue to follow this practice while also continuing to make good use of the ‘fast track’ admission option whereby highly qualified applicants are guaranteed admission to the PhD program, following the completion of their Masters’ degree, provided they achieve specific markers of excellence in their first term of the MMath program.

2. “We recommend that the Department work with the Office of the Associate Provost, Graduate Studies, to try to resolve this issue [the issue being the restricted opportunities to take 600 level courses]. On the part of the Department this may involve making the different expectations (including expected extra work) between the two groups of students [the groups being undergraduate and graduate students] clearer and more explicit in all course descriptions.”

Response

The Department will be very pleased to work on this in consultation with the Associate Provost as it acknowledges the benefit of providing their students with the opportunity to take more of the ‘held-with’ 600 level courses. The Department thanks the Reviewers for acknowledging the high quality of the undergraduate students taking these classes alongside graduate students. There are different expectations for the two groups of students in these courses and the Department is committed to ensuring that this is clearly specified. The Department intends to implement this recommendation quickly.

3. “We recommend that the Department review the comprehensive exam procedures.”

Response

The Reviewers specifically mentioned concerns about the variability of the difficulty of the written exams and the timing of the oral exam. The Graduate Committee takes seriously their responsibility for ensuring consistency of the written exams. This is a topic of on-going discussion in the Graduate Committee. The Graduate Officer will monitor student progress and will advise supervisors when it is time to complete the oral exam.

4. “We recommend that the Department provide some flexibility in the MMath program.”

Response

The Reviewers were specifically addressing the length of the program. Partially in response to a recommendation at the time of the last external review, the Department changed their MMath program from a two-year to a one-year program. As the current Reviewers noted, most faculty members and students are happy with this change. However, there is a diversity of opinion in the Department and the Graduate Committee will discuss this further. Currently students are allowed the flexibility of an additional term when this is felt to be academically appropriate and the Department will continue to consider time extension requests on a case-by-case basis.

5. “The Department should write a 5 year proposal to present to the Dean and the Provost outlining a plan that would achieve this goal [to build the strongest PhD program in Canada] by making appointments above the assistant professor level.”

Response

Over the summer, the Department will develop a long range hiring plan, in consultation with the Dean, as part of the Math Faculty strategic planning process. As the Reviewers remarked, it is only through hiring high quality people that we will be able to substantially improve the quality of our graduate programs. We note that at this time there are no regular faculty members who have indicated firm plans to retire in the next 3-5 years, so hiring would likely require additional resources.

Implementation Plan:

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	We recommend that the Department not offer a direct entry to the PhD program without a MMath (or equivalent) degree	This is the current practice and the Department will continue to follow this practice.	Chair	On-going
2.	We recommend that the Department work with the Office of the Associate Provost, Graduate Studies, to try to resolve this issue [the issue being the restricted opportunities to take 600 level courses]. On the part of the Department this may involve making the different expectations (including expected extra work) between the two groups of students [the groups being undergraduate and graduate students] clearer and more explicit in all course descriptions.”	The Department will work on this in consultation with the Associate Provost as it acknowledges the benefit of providing their students with the opportunity to take more of the ‘held-with’ 600 level courses	Chair	2017-2018
3.	We recommend that the Department review the comprehensive exam procedures	Ensuring consistency of the written exams is a topic of on-going discussion in the Graduate Committee. The Graduate Officer will monitor student progress and will advise supervisors when it is time to complete the oral exam.	Graduate Committee and the Graduate Officer	On-going

4.	We recommend that the Department provide some flexibility in the MMath program.	The Department changed their MMath program from a two-year to a one-year program. As noted, most faculty and students are happy with this change. However, there is a diversity of opinion in the Department and the Graduate Committee will discuss this further.	Graduate Committee and the Graduate Officer	The Department will continue to consider time extension requests on a case-by-case basis.
5.	The Department should write a 5 year proposal to present to the Dean and the Provost outlining a plan that would achieve this goal [to build the strongest PhD program in Canada] by making appointments above the assistant professor level	The Department will develop a long range hiring plan , in consultation with the Dean, as part of the Math Faculty strategic planning process	Chair	2018

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:_____
Chair/Director

Date

AFIW Administrative Dean/Head (For AFIW programs only)

Date

Faculty Dean

Date

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

Date

Associate Vice-President, Graduate Studies and Postdoctoral Affairs
(Formerly known as the Associate Provost, Graduate Studies)
(For Graduate and augmented programs)

Date