UNIVERSITY OF WATERLOO

Final Assessment Report

Mathematics (BMath, Minor), Mathematical Studies (BMath), Mathematical Studies Business Specialization (BMath)

November 2024

Executive Summary

External reviewers found that the Mathematics (BMath, Minor), Mathematical Studies (BMath), and the Mathematical Studies Business Specialization (BMath) programs delivered by the Faculty of Mathematics were in good standing.

"Mathematical Studies, along with its Business specialization, services two types of student within the Faculty: 1) those facing academic difficulties and 2) those looking for greater flexibility in their curriculum. During the site visit, there was consensus from stakeholders that the program provides a necessary function within the Faculty. The program provides an ethical alternative to students who face removal from their program, and it provides a home for students who don't fit as readily into the disciplinary confines of the Faculty's nearly two dozen undergraduate programs."

A total of five recommendations were provided by the reviewers, regarding community, a data science minor, undeclared students, marketing, and academic advising. In response, the program created a plan outlining the specific actions proposed to address each recommendation as well as a timeline for implementation. The next cyclical review for this program is scheduled for 2029-2030.

Enrollment over the past three years

	Math. 3YG (BMath)**	Math. (Minor)	Math. Studies (BMath)	Math. Studies – Co-op (BMath)	Math. Studies – Bus. (BMath)	Math. Studies – Bus. Co-op (BMath)
2024-2025 (CURRENT YR)	0	22	130	163	1	1
2023-2024 (LAST YR)	0	35	113	124	2	2
2022-2023 (THREE YRS)	0	46	94	51	3	5

*Based on Active Student extract from Quest on November 24, 2024.

**The lack of numbers here is because students can graduate with a 3YG but can't enroll in it – See program description.

Background

In accordance with the University of Waterloo's Institutional Quality Assurance Process (IQAP), this final assessment report provides a synthesis of the external evaluation and the internal response of the Mathematics (BMath, Minor), Mathematical Studies (BMath), and the Mathematical Studies Business Specialization (BMath) programs delivered by the Faculty of Mathematics. A self-study (Volume I, II, III) was submitted to the Associate Vice-President, Academic on April 3, 2023. The self-study (Volume I) presented the program descriptions and learning outcomes, an analytical assessment of the programs, including the data collected from a student survey, along with the standard data package prepared by the Office of Institutional Analysis & Planning (IAP). The CVs for each faculty member with a key role in the delivery of the program(s) were included in Volume II of the self-study.

From Volume III, two arm's-length external reviewers were selected by the Associate Vice-President, Academic and Associate Vice-President, Graduate Studies and Postdoctoral Affairs: Professor Julien Arino, Department of Mathematics, University of Manitoba; and Professor Anthony Bonato, Department of Mathematics, Toronto Metropolitan University.

Reviewers appraised the self-study documentation and conducted a site visit to the University on February 5-9, 2024. An internal reviewer from the University of Waterloo, Professor Claude Duguay, Department of Geography and Environmental Management, was selected to accompany the external reviewers. The visit included interviews with the Associate Vice-President, Academic; Dean of the Faculty of Mathematics; Faculty Associate Dean of Undergraduate Studies; Director of the Program, as well as faculty members, staff and current undergraduate

students. The Review Team also had an opportunity to meet with representatives from the library and Co-operative Education.

Following the site visit, the external reviewers submitted a report on their findings, with recommendations. Subsequently, the program responded to each recommendation and outlined a plan for implementation of the recommendations. Finally, the Dean responded to the external reviewers' recommendations, and endorsed the plans outlined by the program.

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

Program Characteristics

Three-Year General

Due to a variety of reasons, there are students who during their undergraduate studies do not wish to continue their honours program. Such students who have met the requirements may opt to select to graduate at that time with the Three-Year General degree to receive recognition for their studies. It also allows students who choose this degree to apply for readmission at a later time to upgrade to an Honours degree. Students are not allowed to enroll in this program during their studies.

Mathematics Minor

The Mathematics Minor provides students outside the Faculty of Mathematics an opportunity to get recognition for a significant amount of course work in mathematics.

Mathematical Studies

Mathematical Studies provides a home within the Faculty for students who have difficulty in the departmental programs or for students who are not interested in any of the departmental programs. Its main advantage of having a high degree of flexibility is also one of its biggest challenges as it does not give the students a clear career direction, nor does it give students an opportunity to meet others in the program. Other challenges of the program are that it is not departmental based and so has no control over the curriculum nor control over any of the courses required for the program, and most students are obligated to enter Mathematical Studies because of high failure counts or low averages. This results in the program being unpopular and

filled mostly filled with students who have damaged academic records and low morale. This leads to the very high attrition rate in the program.

Mathematical Studies Business Specialization

Mathematical Studies Business Specialization is a specialization within the Mathematical Studies program. It provides students who are interested in combing mathematics and business with an option that is more math focused than the Faculty's other math business programs. The attrition rate, especially for the co-op option, is much lower than in Mathematical Studies. The two main reasons for this is that all the students in the program have selected it and hence feel more motivated to complete it, and it provides a much clearer career direction.

Summary of Strengths, Challenges and Weaknesses based on Self-Study

Three-Year General

Strengths

- This program allows students who have met the requirements but do not wish to continue their studies at that time to receive recognition for their studies.
- The program allows students who choose this degree to later apply for readmission to upgrade to an Honours degree.

Mathematical Studies

Strengths

- Mathematical Studies provides a home within the Faculty for students who have difficulty in the departmental programs or for students who are not interested in any of the departmental programs.
- Its high degree of flexibility allows students to gain a breadth of experience and/or focus on an area of individual interest.

Challenges

- About 95% of students in Mathematical Studies are forced into the program because of high failure counts or low averages. Thus, the students are typically weaker and enter with damaged academic records and morale. The program is unpopular which leads to the very high attrition rate in the program.

- There is no incentive for other academic units in the Faculty to develop courses for students in the plan.
- The program has no control over its required courses.
- Some students in the plan comment that they find the flexibility of the program results in a lack of direction.
- Due to the nature of the plan, students enrolled in the plan rarely get to know anyone else in the plan. This contributes to the low morale and negative perspective of the plan.

Weaknesses

- Students who take the non-specialist route for the core course have greatly reduced flexibility in the upper year courses they can take.

Mathematical Studies Business Specialization

Strengths

- Mathematical Studies provides a home within the Faculty for students who are interested in a more flexible and more math focused math business program.
- Since students opt into this program and the program has a better-defined career direction, the program has much lower attrition and high student satisfaction than the Mathematical Studies program.

Challenges

- There is no incentive for other academic units in the Faculty to develop additional courses for students in the plan.
- The program has no control over its required courses.

Summary of Key Findings from the External Reviewers

"Mathematical Studies, along with its Business specialization, services students facing academic difficulties and those looking for more flexibility in courses. Despite the negative tone expressed in parts of the self-study, stakeholders in the program claim it is a necessary one in the Faculty. Issues with the program are its lack of community and the lack of engagement by students and faculty involved with it.

Efforts should be made to build community within the program, enhance its marketing, and provide dedicated advising to its students. Students in a program in the Faculty should be required to declare after their first year of study; students who do not declare should be placed in Mathematical Studies. In addition to these recommendations, a Data Science minor should be developed; this minor should be fashioned so it is attractive to those in Mathematical Studies."

Program Response to External Reviewers' Recommendations

1. **Building Community:** The faculty should strive to foster a sense of community among students in the program. Suggested actions include the following.
    a) Form a Mathematical Studies Working Group: The group would meet regularly to discuss challenges and opportunities for program participants. The group should be chaired by the Program Director and include students, faculty, and advisors. It should meet at least twice a year.
    b) Hold a Mathematical Studies Town hall: The program should hold a moderated town hall, inviting all students, faculty, and administration involved with the program. The event should include an experienced moderator familiar with the program (such as the Dean, Associate Dean, or Program Director), who will lead a discussion about the program's future. We recommend an accompanying social event held immediately after the town hall as an informal meet-and-greet.
    c) Support a Mathematical Studies club: Efforts should be made to support a club run by students in the program. There were conflicting reports during the site visit as to whether such a club is currently active. In any case, and with feedback from a) and b), such a club would serve to heighten a sense of community in the program.
    d) Form a Mathematical Studies mentorship program: For students joining the program sufficiently early, such as those in their first or second year, efforts should be made to match those students with senior ones who can provide academic support and advice.

    Program Response
    a) A Mathematical Studies Steering Committee will be formed. Our plan is to secure faculty members from across the faculty and convene in early Fall 2024 and then on a termly basis moving forward.
    b) Town halls have been organized in the past, with little success; not many students attended. Instead, alumni panels have had marginal success. We are considering holding an alumni panel, in which Mathematical Studies graduates discuss their academic and professional journeys, followed by Q&A. This is something the Steering Committee will decide on.

c) There was a Mathematical Studies club, but it was inactive. As a result, the club was not renewed by the Math Undergraduate Society. Since such clubs are student-run, their initiation and maintenance falls outside the purview of this administration. The administration of the Mathematical Studies programs is supportive of such a club, should a student-lead initiative re-emerge.
d) The Mathematics Undergraduate Office (MUO) runs a Peer-Pair mentorship program, https://uwaterloo.ca/math/math-peer-pair-program. The program started in January 2024 and matches first-year students to upper-year mentors. Most Mathematical Studies students don't declare their major until second year or later. We plan to encourage our upper-year Mathematical Studies students to get involved as mentors so they can be matched with potential Mathematical Studies students.
e)

Dean's Response
We are aware of current efforts to (re-)form a steering committee for the Mathematical Studies program, an initiative we support. We fully agree with the approach taken which is to make use of existing resources (Peer-Pair program) to respond to item d), as opposed to creating a new program that would duplicate those existing efforts. We furthermore point out that this program is run by our Student Relations Officer in the Mathematics Undergraduate Office, which demonstrates our commitment to improving overall student experience in the Faculty.

2. **Data Science minor:** As a recommendation separate from commentary on the Mathematical Studies program but still within the purview of the reviewers, a Data Science minor should be introduced in the faculty. Ideally, this minor could leverage courses taught in the two existing Data Science undergraduate programs in Statistics and Computer Science. Such a minor would be a popular one given market forces and should be structured as flexibly as possible so as to be attractive to students in Mathematical Studies.

Program Response
The creation of a Data Science minor is not within the jurisdiction of the Mathematical Studies program. However, we point out that the Statistics minor and Computing minor are both available to Mathematical Studies students.

Moreover, the Faculty of Mathematics is considering the creation of a Data Science minor, which would be available to students campus wide. Discussions of the appropriate

stakeholders is currently underway and is being led by the Undergraduate Data Science Program Director.

On a different note, we are also considering the creation of a Mathematical Studies - Education Specialization, similar in nature to the Business Specialization, but geared toward students that are interested in teaching math at the middle-school level, or in other math education careers. Consultations are currently underway both within the faculty and with other units across campus who offer courses that might be included in the specialization. Initial consultations with the Math/Teaching plan have been positive and this specialization would not be viewed as competing with that plan, which is co-op only, second-year entry, and geared directly to high school teaching.

Dean's Response
We are indeed working on the creation of a Data Science minor that would be open to all students on campus (assuming some acquired pre-requisites).

3. **Undeclared students:** The present model for undeclared students in the faculty, where students can remain undeclared up to the point of graduation, is unsatisfactory. Students should be required to declare after their first year of study; students who do not declare should be placed in Mathematical Studies. Efforts should be made to position Mathematical Studies as a viable option providing curricular flexibility to students. These efforts will reduce the stigma of the program and enrich its student population.

Program Response
The idea of placing all incoming Math students into Mathematical Studies (by default) was discussed at the Faculty of Math's Undergraduate Affairs Committee (UAC) in April of 2021. However, it was felt that such a change would be confusing for students and might lead them into making choices that limit their options since the math core requirements for the Mathematical Studies program are more relaxed that the math core for most other programs in the Faculty of Mathematics. For example, a student in Mathematical Studies might take a non-specialist course like MATH 207 (Calculus 3 – non-specialist) instead of MATH 237 (Calculus 3 for Honours Mathematics), or STAT 220 (Probability – non-specialist) rather than STAT 230 (Probability).

Undeclared mathematics students do not have the same problem. The math core for undeclared students is the same as the math core for all the undergraduate programs in the Faculty of Mathematics, except Mathematical Studies.

In addition, placing students into Mathematical Studies by default would create a third type of student in the program: 1) those who chose the program actively, 2) those who were placed because of failure count or grades, and 3) those who did not actively choose a major. The addition of this third type of student would not positively enhance the sense of community within the program. Finally, students have to contact a math advisor to declare their major. The fact that a student needs to actively switch into the Mathematical Studies program can give them a sense of agency over their educational future.

Dean's Response
We agree with the response and its supporting arguments.

4. **Marketing:** There should be improved marketing of the program. The program can be positioned as providing flexibility for students who don't wish to specialize in their undergraduate mathematical education. Marketing should be targeted at incoming students and to students in their first year, tying in with recommendation #3.

   Program Response
   The Mathematical Studies major is listed on equal footing along with all the other plans in materials marketed to first-year Math students: https://uwaterloo.ca/math/academic-programs/declaring-majors.

   Mathematical Studies also takes part in the annual "Declare Your Major" event in February, in which Math programs are described to undeclared students.

   We do see an opportunity to improve the Mathematical Studies web page: https://uwaterloo.ca/math/academic-programs/math-studies.

   An effort will be made to improve the visual appeal of the web page, and add content that features its strengths, and perhaps feature some recent alumni. The Faculty of Mathematics marketing team has been making YouTube videos to promote different programs. It would be helpful to have a promotional video for Mathematical Studies, so we plan to approach them to discuss the idea.

   Dean's Response

The response adequately leverages existing resources in the Faculty. Indeed, we identified a need for promoting more actively some of our majors as potential pathways for students not admitted in our most sought-after programs.

5. **Dedicated academic advisors:** There should be dedicated academic advisors provided to students in the Mathematical Studies program. These advisors would specialize in issues related to students joining the program. Advisors should strive to provide appointments to students as they join the program and at the beginning of academic terms when support is most needed. While these advisors may service other programs, efforts should be made to focus first on the needs of Mathematical Studies students, who often face academic difficulties prior to joining the program.

   Program Response
   The Faculty of Mathematics has a team of advisors, 9 of whom specialize in the Mathematical Studies programs (4 more are being trained for September 2024). These advisors also advise on other programs (as the recommendation acknowledges), allowing these advisors to have broad knowledge, which is important for helping students make decisions about their academic futures. Students can book appointments with advisors, and there is a mechanism for expedited referrals in time-critical emergencies.

   As noted in the response to Recommendation 3, the fact that students have to explicitly declare themselves a Mathematical Studies major opens the channels for communication with the Math advisors.

   Dean's Response
   The Mathematics Undergraduate Office has been thoughtfully engaged in recent years in deploying academic advisors in a more efficient, holistic and student-centric approach. The response is in line with that approach, which we support. Generally speaking, we try to refrain from allocating resources narrowly dedicated to a given program as it tends to lead to inefficiencies and creates a negative exposure to sudden changes in staff support level due to leaves and departures.

Recommendations Not Selected for Implementation

Recommendation 1c:

The Mathematical Studies Club would be student-run (as are all Math Society clubs), so the initiative to start and maintain such a club should come from the students. As such, there is no administrative action to take on this recommendation.

Recommendation 3:

Automatically placing undeclared Math students into Mathematical Studies after a certain term could mislead students into choosing non-specialist math courses that rule out all other math programs. Moreover, this automatically placed group of Mathematical Studies students probably will not change the stigma associated with the program. Rather, requiring students to actively declare their major gives them a sense of agency in their education, and encourages further interaction with the math advisors. Additionally, the Education Specialization could help improve morale, giving some students a career path that excites them.

Recommendation 5:

We believe this recommendation is already implemented, and that there is no serious problem with Mathematical Studies students accessing advisors.

Implementation Plan

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	**Building Community:** a) Form mathematical studies working group. b) Hold a mathematics studies town hall. c) Support a mathematics study club. d) Form a mathematics studies mentorship program.	a) Form a Mathematical Studies Steering Committee b) Consider holding an alumni panel c) No action d) Encourage upper-year Mathematical Studies students to take part in the Peer- Pair mentorship program	a) Director of Mathematical Studies b) Director of Mathematical Studies, in consultation with the Steering Committee c) N/A d) First-year Advisors	a) Spring 2025 b) Fall 2025 c) N/A d) Complete
2.	**Data Science Minor:** Introduction of a data science minor in the faculty to attract students in mathematical studies.	Consider the creation of a Data Science minor	Associate Dean Undergraduate Studies, Faculty of Mathematics and Undergraduate Data Science Program Director	Fall 2026
3.	**Undeclared Students:** Students should be required to declare after their first year of study.	No action	N/A	N/A
4.	**Marketing:** Marketing should be targeted at incoming students and to students in their first year, tying in with recommendation #3.	a) Overhaul the Mathematical Studies web page b) Produce promotional video featuring Mathematical Studies	a) Director of Mathematical Studies b) Faculty of Math marketing team	a) Winter 2025 b) Winter 2025

5.	**Dedicated academic advisors:** There should be dedicated academic advisors provided to students in the Mathematical Studies program	No action	N/A	N/A

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

Date of next program review 2029-2030
Date

Signatures of Approval

Feb.26, 2025
Chair/Director Date

AFIW Administrative Dean/Head (*For AFIW programs only*) Date

Mark Giesbrecht
Dean, Faculty of Mathematics
29 May 2025
Faculty Dean Date

Note: AFIW programs fall under the Faculty of ARTS; however, the Dean does not have fiscal control nor authority over staffing and administration of the program.

Feb.14, 2025
Associate Vice-President, Academic Date
(For undergraduate and augmented programs)