UNIVERSITY OF WATERLOO

Final Assessment Report

Mathematics/Teaching (BMath), Mathematics for Teachers (MMT)

November 2024

Executive Summary

External reviewers found that the Mathematics/Teaching (BMath) and Mathematics for Teachers (MMT) programs delivered by the Department of Faculty of Mathematics were in good standing.

Mathematics/Teaching (BMath)

"In our review of the program, including discussions with members of the teaching staff and student body, as well as with the Director, we can see that this is a robust program that helps students who might be interested in mathematics teaching determine whether the teaching field and/or work in mathematics education is of interest to them."

Mathematics for Teachers (MMT)

"This program fills a unique niche that is well thought of and maintains a steady enrollment. The retention of students in this program is high and the program completion rates are also high. The core courses, selection of electives, and the culminating activity option at the end of the program serves to meet the needs of the intended audience of the program: secondary mathematics teachers."

A total of five recommendations were provided by the reviewers, regarding mathematics research, connections to Teacher Education program, diversity of teaching experiences, capstone topics, and mathematics education literature. 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

	BMath	MMT
2024-2025 (CURRENT YR)	32	180
2023-2024 (LAST YR)	27	185
2022-2023 (THREE YRS)	31	165

*Based on Active Student extract from Quest on November 14, 2024.

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/Teaching (BMath) and Mathematics for Teachers (MMT) programs delivered by the Department of Faculty of Mathematics. A self-study (Volume I, II, III) was submitted to the Associate Vice-President, Academic and Associate Vice-President, Graduate Studies and Postdoctoral Affairs on April 19, 2023 (BMath) and December 5, 2022 (MMT). 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 Richelle Marynowski, Faculty of Education, University of Alberta; and Professor Christine Suurtamm, Faculty of Education, University of Ottawa.

Reviewers appraised the self-study documentation and conducted a site visit to the University on October 16-20, 2023. An internal reviewer from the University of Waterloo, Professor Juan Moreno-Cruz, School of Environment, was selected to accompany the external reviewers. The visit included interviews with the Vice-President, Academic & Provost; Associate Vice-President, Academic and Associate Vice-President, Graduate Studies and Postdoctoral Affairs; Dean of the Faculty of Mathematics; Faculty Associate Dean of Undergraduate Studies; Directors of the Programs; Director of the Centre for Education in Mathematics (CEMC); as well as faculty members, staff and current undergraduate and graduate 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

Undergraduate Program (BMath)

The Mathematics/Teaching BMath program graduates students with an Honours Mathematics Co-op degree, a minimum of 8-months teaching experience in secondary schools, a course in the "Introduction to Mathematics Education", professional training, and additional co-op work experience.

The Mathematics/Teaching program exists in two different forms. First, Mathematics/Teaching exists as a stand-alone program within the Faculty of Mathematics. Students can enroll in and graduate from the Mathematics/Teaching plan which has its own set of academic degree requirements. Second, Mathematics/Teaching exists as an optional addition to most other undergraduate plans within the Faculty of Mathematics. For example, students admitted to Mathematics/Teaching could choose to complete the degree requirements for Applied Mathematics, and graduate with an Honours Mathematics degree in Applied Mathematics/Teaching. Each of these programs is available as co-op only and are second-entry, typically requiring admission at the second-year level.

Graduate Program (MMT)

The MMT is a graduate part-time, online only, professional Master's program aimed at current secondary school teachers. Most teachers in the program teach full-time while taking courses each term.

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

Undergraduate Program (BMath)

Strengths

- The academic degree requirements permit a high degree of flexibility, allowing students to follow the Mathematics/Teaching plan, thus gaining a breadth of experience, or to follow the degree requirements from another academic unit, thus focusing on an area of individual interest.
- Through teaching co-op placements, students receive direct, relevant, and practical experience in their intended profession and can determine if they are on the correct career path prior to applying to a B.Ed. degree. In addition, their non-teaching work terms help inform the students' teaching.

- The co-op process for the students' two teaching work terms is unique. It is administered outside of Waterloo Works, and thus the opportunity and competition for these teaching placements is strictly between the students in Mathematics/Teaching.
- A graduate of this program will have demonstrated significant quantitative abilities across many branches of mathematics, thus enhancing their future teaching – a positive for mathematics education.
- MTHEL 206 is only open to students in the program, making the class size small, thus allowing for multiple opportunities for students to teach and interact with their peers, while learning about and engaging in successful teaching practices.

Graduate Program (MMT)

Strengths

- Meeting a clearly identified need among mathematics educators to instill greater understanding and confidence in their mathematical skills, thereby enhancing their classroom teaching.
- A combination of breadth and depth of material providing an appropriate level of challenge for teachers that is mathematically rigorous.
- Well-designed courses created with the online learner in mind.
- The variety of courses available including the suitability of the courses to the audience consisting of a broad range of abilities and previous formal mathematics education
- Passion of all MMT instructors and their talent for teaching.
- Flexibility and accessibility provided by online format, asynchronous learning, and instructors' accommodation of teachers' restricted schedules and busy lives.
- High success and low attrition rates in courses and program.
- Reasonable cost of program compared to other programs and courses for teachers, and reasonable rewards for completion.
- Commitment at the Faculty and University level to support the program and its goals.

Undergraduate Program (BMath)

Challenges

- Many of our students have Mathematics and Computer Science as their two teachable subjects, and few Faculties of Education in Ontario offer this combination, making admission to these degree programs more difficult for these students.

- To balance the number of students doing teaching co-op placements in fall with those in winter each year, requires some students to complete sequence changes, which can pose challenges.
- The salary received for teaching co-op work terms is often well below the average for the Faculty of Mathematics co-op work terms.
- The schools with available funding to hire students from the program are typically independent or private, and thus do not provide a diverse range of employment experiences or geographical locations.

Graduate Program (MMT)

Challenges

- Maintaining quality and size of application pool; reaching teachers to promote the program and its scholarships.
- Assessing applicants' suitability for the program given a wide variety of backgrounds and in many cases, a long period of time since their last period of formal education.
- Supporting students who struggle with the material and transition to becoming a student again.
- Targeting courses to teachers who teach using a different style than Universities do
- Addressing external demands on students' time given that they are full-time professionals, amplified by the global pandemic and its impact on teachers.
- Determining the ideal amount of pedagogy and direct application to classroom teaching in each course.
- Refreshing the program to reflect new expectations as technology evolves and online learning and teaching is now a ubiquitous experience.
- Navigating issues surrounding intellectual property rights towards course materials
- Working with central University policies and procedures often designed around more traditional programs and formats.

Undergraduate Program (BMath)

Weaknesses

- Matching the number of new employers to the number of new admissions is a challenge that has forced us to secure some employers that do not provide the traditional high school teaching placement.

Graduate Program (MMT)

Weaknesses

- Creating and maintaining community with students and addressing the isolation some students experience.
- Maintaining contact and relationships with MMT alumni.

Summary of Key Findings from the External Reviewers

"While we cannot comment on the specific areas of mathematics, the broad selection of mathematics courses for both programs are excellent. Students in both programs have an opportunity to engage in a variety of electives that broaden their understanding of mathematics and different fields of study. Both programs have a connection to teachers and teaching, particularly at the high school level; however, there is an absence of connection to the math education research community."

Mathematics/Teaching (BMath)

"Our recommendations for enhancing the program are suggestions to make the program more attractive to those who might want to pursue a teaching career."

Mathematics for Teachers (MMT)

"Our recommendations are for enhancing the program believing that the program is generally a strong one and is not overly resource intensive from the university perspective."

Program Response to External Reviewers' Recommendations

1. **Integrate Mathematics Education Research:** In many conversations with instructors, directors, and students, mathematics education research was regarded as learning about pedagogy. Mathematics Education Research is so much more than that and we think that there are places where both programs might benefit from students being aware of research in mathematics education. For instance, students in the UMT program might benefit from being exposed to research on how students develop particular mathematical concepts and what a research-based learning trajectory might look like for that concept, or on research in how particular aspects of coding can help students develop stronger understanding of some mathematical topics such as iterative functions, to name a few. Exposure to this research could be in a second education course that students take after they have done at least one teaching co-op placement and integrated into their initial course. For the students in the MMT program, examining research-based approaches to a topic for which they are designing a module for their capstone project might provide a bit more rigor to their understanding of both the mathematics of the topic and how students develop an understanding of the topic. Connections to Mathematics Education could also be made through attendance at the Fields

Mathematics Education Forum, reading mathematics education journals that bring research to practitioners, etc.

Program Response (Undergraduate – BMath)
We agree that students in the Mathematics/Teaching program may benefit from being made aware of some of the current research in mathematics education. Given the volume of content that needs to be covered in MTHEL 206 to prepare Mathematics/Teaching students for their first teaching co-op work term, we are unable to devote more than two days of class to this. It is our plan that beginning in the next offering of MTHEL 206 (Spring 2024), Mathematics/Teaching students will research a chosen topic in mathematics education and present a 5-minute summary of their findings to their fellow classmates. It is also our hope to invite a mathematics education researcher as a guest lecturer for one day of class in each term that MTHEL 206 is offered, with the commencement of this yet to be determined. The cost for this presentation will be covered by the CEMC. The addition of these two new complementary activities will expose Mathematics/Teaching students to current research and trends in mathematics education, with further acquisition of such knowledge to be obtained within their Bachelor of Education coursework.

Program Response (Graduate – MMT)
While the primary audience in the MMT is currently active secondary school teachers, the goal of the program is mathematical knowledge, and the courses are largely courses where the teachers in the program improve their own mathematical abilities. Some courses in the program do make connections between mathematical ideas and the teachers' day-to-day practice, but the content itself is rarely if ever content that teachers would be teaching directly to their students. Therefore, there would be few places in which mathematics education research could be organically connected in the MMT. We also know that there are many avenues for active secondary school teachers to learn more about mathematics education research and about pedagogy, but few that target mathematics directly. As the program continues to evolve, we will continue to be open to opportunities to integrate these ideas.

Dean's Response
We support the differential approach chosen by the two programs to address this recommendation, as they are both adhering to their respective program's goals and objectives.

2. <u>Specific to the Undergraduate Program (BMath)</u>
Create Incentives through connections to a Teacher Education Program: The current Undergraduate Math Teaching (UMT) program is an excellent program that helps to prepare undergraduate teachers to consider mathematics teaching and develop teaching skills. It

would be nice to see the enrollment increase as it is a strong preparation. However, we recognize that students still having to complete a 2- year teacher education program after their co-op undergraduate degree to become certified as a teacher may be a deterrent to them entering the UMT program. We suggest finding ways to create some incentives. These might include: automatic entry into a 16 - 18 month teacher education program after the UMT, lobbying to have computer science teachable courses offered online so that students could attend any Faculty of Education for their math teachable and take the Computer Science teachable online, or seeing if at least one of the teaching co-op placements could count towards the increased practicum days required by the Ontario College of Teachers to be a certified teacher.

Program Response (Undergraduate – BMath)

The Mathematics/Teaching program affords its students significant flexibility while they prepare to be a teacher during their BMath degree. These include, but are not limited to:

- The choice to complete 4, 5 or 6 co-op work terms.
- The ability to graduate in a minimum of 12 terms or if needed to take much longer, through for example, reducing course loads, taking additional courses or a term off, increasing the number of co-op terms, and so on
- The opportunity to fulfill faculty of education application requirements by completing the necessary courses from a choice of more than 20 possible second teachable subject areas.
- The option to begin their B.Ed. degree at any of the available starting points following the completion of their BMath degree.
- The choice to make application to any faculty of education, anywhere in the world.

While a partnership with a university that offers Mathematics/Teaching students direct entry into their B.Ed. program may provide some incentive, such an agreement would also significantly diminish or altogether eliminate the advantages previously listed. A number of incentives are currently available to encourage application to the Mathematics/Teaching program. These include, but are not limited to:

- MTHEL 206, Introduction to Mathematics Education, a course open only to students in the program
- The opportunity to gain practical teaching experience through a minimum of 8 months in high school co-op placements.
- Exclusive access to our co-op teaching employers through application, interviews and matchings
- The ability to combine teaching with most undergraduate plans within the Faculty of Mathematics
- Advising support for many teaching-related queries including the application process to faculties of education
- Inclusion in a UW community of like-minded, pre-service mathematics teachers

Additional incentives may help to increase program enrollment, although historically speaking, it has been external political factors and the availability of teaching jobs within Ontario that have dictated demand for this program. Careful consideration would need to be given to the introduction of new incentives. For example, it is not clear that the potential incentive of completing fewer practicum days outweighs the advantages of doing more. As best we can, Mathematics/Teaching must ensure that students are choosing the program and this career path for the proper reasons.

Dean's Response

The reviewers are suggesting interesting ideas to increase enrollment but as stated in the response this could have unintended effects, so needs to be assessed carefully.

3. Specific to the Undergraduate Program (BMath)

Increase the Diversity of Teaching Experiences: Due to the lack of access to co-op teaching placements in the public school system, the teaching experiences of the students in the Mathematics Teaching program are often limited to independent/private schools and experiences with CEMC. In most cases, this limits the experiences of the UMT students who are often teaching students who have had privileged educational experiences. This not only provides a narrow view of the learner, but also the learners who most need extra support that a Mathematics Teaching student might offer are not afforded this opportunity. There might be several ways to provide such experiences such as out of the province and/or country co-op teaching co-op placements; U of W offering some outreach sessions for high needs students which could become teaching placements for Mathematics Teaching students; or seeking alternate co-op teaching placements such as in children's hospitals, or immigration or community centres.

Program Response (Undergraduate – BMath)

We agree that the current set of co-op teaching employers does not provide a wide range of experiences for our Mathematics Teaching students. We appreciate the reviewers' ideas about diversifying the types and locations of these employment opportunities.

The Mathematics/Teaching program works carefully to balance supply and demand for our co-op employment opportunities. Should student enrollment in the program increase in the future, the program will seek to add employers who broaden the experiences for its students.

Dean's Response

As stated in the introduction of the recommendation, this lack of diversity issue mostly stems from external factors beyond the control of the programs.

4. Specific to the Graduate Program (MMT)

Potential Capstone Topics/Offerings: The capstone is the culminating activity of this program which, for the most part, asks students to create an enrichment unit that they could potentially use with their own students. We wonder if there are other potential capstone activities that could be offered to students. For example, students could choose one of several options: an enrichment unit, a lit review of the Scholarship of Teaching and Learning in Mathematics (either within K - 12 education or post-secondary mathematics teaching and learning), select a topic that they currently teach and develop resources that reflect current research in the topic, or select a topic in one of the courses they took and map the continuum of learning across the grades that would lead to a deep understanding of the topic.

Program Response (Graduate – MMT)

Because of the goals of the MMT and the nature of its courses, it is important that the capstone stay explicitly focused on mathematical content as it currently is. That is, the focus of the MMT is to increase teachers' depth and breadth of understanding of mathematics. MATH 699 (the capstone project) is meant to be a culminating experience in line with this focus that demonstrates an ability to transfer this knowledge. It specifically involves the creation of an enrichment module for MMT teachers' own students. This can be informed by mathematics education research, but to shift the focus away from mathematics would put this important milestone out of synch with the rest of the content of the program.

Dean's Response

A capstone project must usually be strongly connected to what was learned in the program, so we agree with the response.

5. Specific to the Graduate Program (MMT)

Access to Mathematics Education Literature: We acknowledge that the focus of library resources is on mathematics, however, we see an opportunity to engage students in the MMT with the Mathematics Education literature to support their practice of teaching alongside building their mathematics knowledge. For example, access to some practitioner journals (National Council of Teachers of Mathematics (NCTM), OAME Gazette, delta-K (the journal of the Mathematics Council of the Alberta Teachers Association), and other provincial mathematics teacher education journals. Another resource that could be incorporated is the Fields Mathematics Education institutes or sessions. These are invaluable opportunities to engage with others about teaching and learning mathematics at all levels.

Program Response (Graduate – MMT)

Over the next two years, we will work on "crowd sourcing" a list of such journals that can be updated annually. This list will be made available to teachers in the MMT via our Community Site, thereby allowing teachers in the program to seek out materials that meet their

individualized needs, rather than us creating a library here.

Dean's Response
The proposed way of addressing this recommendation is appropriate.

Recommendations Not Selected for Implementation

- **Recommendation 2:** Create Incentives through connections to a Teacher Education Program. The rationale for not implementing this recommendation is given above.
- **Recommendation 4:** Potential Capstone Topics/Offerings The rationale for not implementing this recommendation is given above.

Implementation Plan

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	Integrate Mathematics Education Research.	**Undergraduate (BMath)** • In MTHEL 206, Mathematics/Teaching students will research a chosen topic in mathematics education and present a 5- minute summary of their findings to their fellow classmates. • Invite a mathematics education researcher as a guest lecturer for one day of class in each term that MTHEL 206 is offered. **Graduate (MMT)** This recommendation will be kept in mind as the MMT continues to evolve.	• MTHEL 206 instructor • MTHEL 206 instructor with the support of the Director of Mathematics/Teaching • MMT Director	• Spring 2024 • Spring 2025 • No timeline
Specific to the Undergraduate Program (BMath)				
2.	Create Incentives through connections to a Teacher Education Program.	This recommendation will not be implemented.	N/A	N/A
3.	Increase the Diversity of Teaching Experiences.	This recommendation will be considered should student enrollment in the program increase in the future. The program will seek to add employers who broaden the experiences for its students.	• Director of Mathematics/Teaching	• To be determined

Specific to the Graduate Program (MMT)				
4.	Potential Capstone Topics/Offerings	This recommendation will not be implemented.	N/A	N/A
5.	Access to Mathematics Education Literature	A list of teacher-recommended journals will be created and posted in the MMT Community Site.	• MMT Director with support from staff	• December 2025

The Program Directors, 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

Mar. 20, 2025

Director of Mathematics/Teaching (BMath) Date

Mar. 19, 2025

Director of Mathematics for Teacher (MMT) Date

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

Mark Giesbrecht
Dean, Faculty of Mathematics Dec. 19, 2024

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.

Dec.16, 2024

Associate Vice-President, Academic Date
(For undergraduate and augmented programs)
On behalf of the Associate Vice-President, Graduate Studies and Postdoctoral Affairs