

CHAMPIONING IMPACTFUL TRANSFORMATION

CENTRE FOR EDUCATION IN
MATHEMATICS AND COMPUTING



UNIVERSITY OF
WATERLOO




The CENTRE for EDUCATION in
MATHEMATICS and COMPUTING

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LETTER FROM THE DIRECTOR

IAN VANDERBURGH





More than 60 years ago, the CEMC's roots were put down in Southwestern Ontario, where a prescient group of secondary school mathematics educators decided they wanted to provide more opportunities for their students and students from nearby schools. I wonder whether they dreamed that someday their work would lead to globally impactful work by a dedicated team at the University of Waterloo.

As you'll read in this report, the CEMC works across many different segments of mathematics and computing education and has embarked on new and ambitious projects to bring our experience and expertise to larger and larger audiences. From visiting students in the Northwest Territories to working with educators in elementary school classrooms in Ontario to walking with partners in Kenya, my colleagues in the CEMC inspire hundreds of thousands of students and tens of thousands of teachers at thousands of schools in dozens of countries annually. (As I write this, I note that in the last week alone I've been in meetings where we've discussed mathematics education on five continents!)

Through all of this, it is important that, while we reflect on the scale and scope of the work that we do, the goal in the end is the impact that we have on individuals, opening their minds to the myriad of possibilities mathematics and computing offer them, regardless of their specific path in life. The work of the CEMC is indeed transformative for so many young people.

We could not accomplish all of this without thoughtful friends and supporters like you. Thank you for believing in us!

IAN VANDEBURGH

DIRECTOR, CENTRE FOR EDUCATION IN MATHEMATICS AND COMPUTING

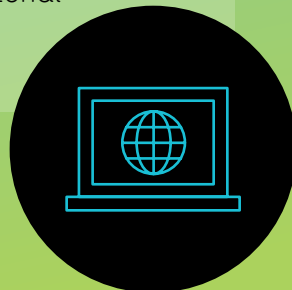
SOME OF OUR INITIATIVES

**CEMC ACTIVITIES AND RESOURCES
ARE DESIGNED TO OFFER SUPPORT
TO THE ENTIRE COMMUNITY –
STUDENTS, TEACHERS, PARENTS
AND GUARDIANS – AND INCLUDE:**

TOOLS AND RESOURCES

These resources are available on our website, are free to use, and do not require registration.

- > Problem of the Week
- > Problem of the Month
- > Problems with Purpose
- > Problem Set Generator
- > Courseware
- > CS and Society
- > Contest Preparation Material
- > Past Contests



CONTESTS



CEMC contests are designed with a gradual increase in difficulty to motivate more learners to confidently attempt math contests, creating a mindset for critical thinking and a love for learning.

- > 13 mathematics and 3 computing contests for learners of Grades 5 to 12
- > Multiple-choice and full-solution contests

MASTER OF MATHEMATICS FOR TEACHERS



The Master of Mathematics for Teachers (MMT) program offers teachers the unique opportunity to deepen their understanding of the core foundations of mathematics – online and at their own pace. Designed to strengthen teachers' knowledge of mathematics and its applications, the MMT combines flexibility with world-class education to deliver a rich learning experience.

- > Fully online, part-time program
- > Designed for in-service teachers of secondary school classrooms

EVENTS AND WORKSHOPS



CEMC workshops and events offer engaging in-person and online experiences to enhance students' mathematical and computing skills. They also provide opportunities for educators to come together to share their knowledge and expertise, build new connections and tap into renewed enthusiasm for mathematics and computer science.

- > **Student Workshops**
 - Math Circles
 - Discovering Math Camp
 - Workshops for people of gender identities under-represented in mathematics and computer science
 - CS Escape
 - Seeing Possibilities and Rewards in Computer Science (SPARCS)
 - Think About Math! (TAM)
 - Invitational workshops
 - Exploring Mathematics and Computer Science Workshop (EMACS)
 - Lloyd Auckland Invitational Mathematics Workshop
- > **CEMC Visits Schools**
- > **Summer Courses**
- > **Educator Development**
 - Summer Conference for Computer Studies Educators
 - Summer Conference for Mathematics Educators
 - EFGH Marking

LEARNING ACROSS BORDERS – CEMC VISITS SCHOOLS PROGRAM

THE CEMC VISITS CLASSROOMS IN ONTARIO, ACROSS CANADA AND AROUND THE WORLD TO DELIVER FUN, ENGAGING SESSIONS THAT SPARK STUDENTS' INTEREST AND BUILD THEIR CONFIDENCE IN MATHEMATICS.

BY LATA PUNETHA

Mathematicians and computer scientists from the Centre for Education in Mathematics and Computing (CEMC) and the University of Waterloo have been visiting classrooms to inspire students for more than 50 years. From local schools in Ontario to classrooms in Canada as far as Yellowknife, and even internationally from Jamaica to Vietnam, the CEMC has been dedicated to engaging with interested math and computing students worldwide.

Each visit features a workshop focused on problem-solving and introduces students to real-world applications of and careers in mathematics and computer science. Typically, educators from the CEMC and the Faculty of Mathematics at the University of Waterloo engage with students from grades 7 to 12, working together to tackle intriguing problems in mathematics and computer science. These interactive sessions encourage both individual and group problem-solving. The CEMC provides this service free of charge to all schools.

“This is the second year we were lucky enough to have Dr. Ian Payne come and share his love of math with our school. Ian showed the students that math could be exciting and cool. Students spent the day engaged with math, applying algebra and being amazed with mathematical concepts. I am certain that Dr. Payne has influenced our students' mathematical trajectory and has inspired all of us to see math in a different way. Thanks again for that amazing opportunity!”

– EDUCATOR FROM NORTHWEST TERRITORIES



Local schools often reach out to the CEMC to request a visit. In the 2023/2024 school year alone, CEMC educators visited more than 100 schools across Canada. By bringing educators directly into the classroom, the program reaches a wider array of students, including those in remote areas. In these settings, classroom educators often wear many hats, teaching various subjects and forming close bonds with their students. This multi-disciplinary approach allows them to draw connections between different subjects. Ian Payne, a faculty member at the CEMC, visited a school in a community near Yellowknife twice in recent years. He observed that the educators there were energetic and deeply engaged, fostering a close-knit learning environment thanks to a low student-to-teacher ratio. The students, he noted, were sharp and were keen to continue learning beyond their standard curriculum.

On the international front, the CEMC visited approximately 115 schools across a dozen countries, sharing knowledge about mathematics and computer science education. Each country has a particular approach to mathematics education, with some focusing on skill-based learning while others emphasize problem-solving. These visits provide a valuable learning experience for CEMC educators as well.

Mike Eden, a faculty member at the CEMC, reflected, “Depending on which part of the world you are in, math can be more important to educators and students - they want to learn newer topics and they don’t want you to stop teaching. There is a certain passion for learning which makes it fun to teach math to these students.”

Beyond academics, seeing an educator from Waterloo who looks like them and speaks their language can be a powerful motivator for students. Comfort Mintah, a faculty member at the CEMC, remarked, “It is great for students to see someone who belongs to diverse backgrounds such as their own and has made a career in mathematics. It makes them think that if they can do it, so can I – and this can make a big difference in the life of a student.”

Before any school visit, CEMC educators invest time researching the school’s curriculum and current academic schedule to tailor problem-solving sessions to match the students’ curricular level, ensuring they remain engaged and enjoy the experience. Occasionally, these visits also include meetings with school educators to discuss resources and lesson planning strategies.

The CEMC Visits Schools program makes a big impact by inspiring a love for math and computer science in students. It helps improve students’ problem-solving skills and opens their eyes to future career opportunities. By focusing on inclusivity and personalized learning, the program ensures that all students, no matter where they are from, get a chance to know more about what math and computing education can offer. As the CEMC continues to visit more schools, it remains dedicated to helping students become the next generation of thinkers, innovators, and problem-solvers, showing that with the right support, every student can succeed in mathematics and beyond.

ENGAGING YOUNG MINDS IN MATH

CEMC'S ELEMENTARY INNOVATION PROJECT WILL PROVIDE FREE ONLINE SUPPLEMENTARY MATERIALS THAT ENRICH STUDENTS' COMPREHENSION OF THE MATH CURRICULUM AND HELP TEACHERS DELIVER LESSONS WITH CONFIDENCE.

BY LATA PUNETHA

This past year, experts from the CEMC visited vibrant classrooms of grades 4 to 6, as a new initiative took root, aiming to support educators, students, parents and guardians in their mathematical journey. In its first phase, the Elementary Innovation Project aims to provide resource support in the form of mathematical courseware to grade 4 to 6 classrooms.

Designing courseware or any new resource for curriculum support requires hours of research and testing in the classroom to ensure that the material created is appropriate for the intended audience. Recognizing the importance of direct interaction with students and educators, the team working on this project visited more than 15 schools in the Waterloo, Guelph, Wellington County, Peel and Toronto regions, engaging with multiple classes during each visit, reaching over 1200 students in the past year.

“Everyone agreed, the lessons were great, and students really enjoyed them. One thing I did really like is that no matter the level of my students, they were still able to try each activity as there were many entry levels. I have some students significantly below grade 6 level however, they were still able to participate in all activities. I also really liked that they could be done in short periods of time. These were great and I plan on continuing them in my classroom.”

– EDUCATOR



These visits are crafted to be more than just lessons; they are experiences. The team designed activities that encourage students to interact with math in playful and exploratory ways. Instead of traditional problem-solving methods, students are invited to approach problems through puzzles and games, sparking curiosity and engagement. This approach is particularly effective as it does not rely on the students' progress through the curriculum, allowing all to participate regardless of their progress in the school year.

Each session, lasting about 50 minutes, is filled with opportunities to play and discuss what it means to be a mathematician. The focus is not on finding the right answer but on the process of exploration and inquiry. This method helps students to engage deeply with the material, fostering a love for learning and resilience in the face of challenging problems.

Feedback from these school visits has been overwhelmingly positive. The progress made this year has set a solid foundation for the upcoming phase of the project.

“The presenter was fantastic, and the problems were engaging – hard to get them to switch from thing to thing!”

– EDUCATOR

“One of the teachers whose class you worked in just came to tell me how much her class loved it, in fact telling me they asked if you could come back again!”

– EDUCATOR

“Great activities! Great presentation! Great interaction with the kids! All around – this is a great program. I’d really be interested in more CEMC resources, presentations, programming materials, etc., in the future.”

– EDUCATOR

CHANGING THE FACE OF MATHEMATICS EDUCATION IN KENYA

THE CEMC HAS BEEN ENRICHING MATHEMATICS EDUCATION IN THREE AFRICAN COUNTRIES – GHANA, RWANDA AND KENYA – SINCE 2021 TO MEET AN ACUTE NEED FOR SKILLED STEM WORKERS IN THE CONTINENT.

BY LATA PUNETHA

In the heart of Kenya, a transformative educational initiative is gaining momentum, aiming to transform how mathematics is taught and learned. Traditionally, the education system in Kenya has approached math as a subject of formulas and memorization. Over the past three years, the CEMC has been collaborating with Kenyan educational institutions on shifting this paradigm towards problem-solving, promoting critical thinking and innovation among young minds.

“This initiative is life-changing, not just for the students but for the entire country. It aims to create leaders and problem-solvers who can address Kenya’s challenges with novel solutions. By starting with math, we are training young minds to think critically, laying the foundation for future leaders who can drive change across Africa. One of these students could one day become president, equipped with the skills to solve complex problems and lead the nation towards a brighter future.”

– WESLEY KORIR, ADVISOR TO THE DIRECTOR ON AFRICA INITIATIVES



Now in its third year, the CEMC is working with the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) to conduct math contests for Kenyan students focused on problem-solving. This initiative is not just about contests; it also includes training of math educators and engaging activities like math camps for students in collaboration with the University of Nairobi. Educators are being offered professional development activities to give them the skills to understand, solve and create contest questions with a balance between content commonly taught in Kenyan classrooms and questions that require a problem-solving approach.

The contest unfolds in three rounds, starting with an open call to all schools across Kenya. This year alone, nearly 8000 students participated in the first round. From this pool, about 1200 were selected for the second round, which consists of a program developed by the CEMC that focuses on problem-solving skills. The third round narrows the field to 100 students who receive advanced training in Nairobi, tackling high-level problems akin to those in the Pan African Mathematics Olympiad (PAMO). Ultimately, the top students are chosen to represent Kenya in prestigious competitions like PAMO, the International Mathematical Olympiad (IMO) and the East African Math Olympiad.

Since its inception, over 20 000 students have participated in these contests. The contests are free, eliminating barriers for students from smaller, rural schools who now have the chance to compete against their peers from larger institutions.

Wesley Korir, Advisor to the Director on Africa Initiatives at the CEMC, remarks, “This initiative is life-changing, not just for the students but for the entire country. It aims to create leaders and problem-solvers who can address Kenya’s challenges with novel solutions. By starting with math, we are training young minds to think critically, laying the foundation for future leaders who can drive change across Africa. One of these students could one day become president, equipped with the skills to solve complex problems and lead the nation towards a brighter future.”

This initiative is more than an educational reform; it demonstrates how nurturing critical thinking and innovation can deeply impact young minds and lead to significant impact in the future.

A JOURNEY OF LIFELONG LEARNING

HOW CEMC'S MASTER OF MATHEMATICS FOR TEACHERS PROGRAM OFFERS EDUCATORS THE UNIQUE OPPORTUNITY TO DEEPEN THEIR UNDERSTANDING OF MATHEMATICS – ONLINE AND AT THEIR OWN PACE.

BY LATA PUNETHA

Laurent Gerard Fontaine heard about the Master of Mathematics for Teachers (MMT) program when it first began in 2010. He encountered an idea that would stay with him for many years: pursuing a master's degree in mathematics. Today, after graduating from the MMT in 2023, Fontaine shares, "In hindsight, I feel I should have pursued the MMT ten years ago."

At the time, he had young children and new responsibilities, so he put the idea on hold. As his children grew older and more independent, the thought of pursuing a master's degree resurfaced. This time, he felt ready. After researching several master's degree programs, he chose the MMT because it focused purely on mathematics and its application to education, rather than on pedagogical methods. Along with a pay raise being a strong motivator, this distinction appealed to him, as he wanted to deepen his understanding of math itself and not just learn how to teach it better.

Since the MMT is part-time and completely online, Fontaine was able to pursue it along with his classroom commitments. Being a high school educator in Saskatchewan, he began to involve his students in his learning process. From the MMT he learned about using LaTeX for assignments and used it to create assignments for his students. Watching him learn and apply his learning in the classroom set a wonderful example for his students that learning is a continuous journey. It wasn't just about number crunching; there was a whole world of mathematical theory and application to explore. Fontaine's students saw him struggle through tough courses, particularly the course in problem solving, which required a significant amount of work.



Fontaine took courses on algorithms and calculus, even though he had not studied them in depth before. He understood the issues that his own students face now since he was both a student and an educator. He connected with other MMT students from the same province, including one who had interned with him earlier, fostering new friendships. Learning from his experience, recently one of Fontaine's friends signed up for the MMT as well.

An awardee of the MMT Indigenous Scholarship, Fontaine has been a great influencer for his students, encouraging them to apply for scholarships and teaching them about financial literacy.

With award-winning professors teaching the course, Fontaine exclaimed that all instructors in the MMT inspired him to leave his comfort zone and try difficult courses. Going through the process of learning math again was invigorating for him. It required constant logical thinking and understanding the reasoning behind every step. "Everything in math has a proof, and I enjoyed diving into books to research the history of mathematics. Writing long papers, particularly 25-page essays on the contributions of mathematicians, was intimidating but rewarding," he says.

"Since my approach to teaching has always been based on problem-solving, I enjoyed pursuing the MMT as this resonated with my teaching ideologies," Fontaine reflects. Today, he feels like he has delved deeper into math and is now able to be a better educator to his students, showing them the importance of lifelong learning.



"Since my approach to teaching has always been based on problem-solving, I enjoyed pursuing the MMT as this resonated with my teaching ideologies,"

– LAURENT GERARD FONTAINE

OPENING DOORS TO REWARDING CAREERS IN MATH

WATERLOO ALUM JOSE AVILEZ (BMATH '20, MMATH '21) TOOK A WINDING PATH TO TWO MATHEMATICS DEGREES AND A SUCCESSFUL CAREER IN FINANCE. NOW, HE IS HELPING YOUNG STUDENTS TO CHOOSE MATH WITH CONFIDENCE.

BY ROBIN MORDEN



Jose Avilez's love of mathematics began in high school. He was won over by the subject's rigorous and deductive approach to problem-solving. "In mathematics, everything is built from the ground up," says Avilez. "To me, this method has always been very appealing."

He enrolled in an International Baccalaureate program that covers some topics in more depth than typically encountered in high school and enjoyed every moment of it. Yet, despite his passion for the subject, Avilez did not pursue mathematics after high school. Instead, he enrolled in medical school, believing it a safer choice for his future job prospects.

"I thought if you go to medical school, you're guaranteed a job," says Avilez. "Nobody told the 16-year-old me that, if you study mathematics, your job prospects are also going to be very good."

Unhappy in medical school and missing math, Avilez left the program and transferred to Waterloo to pursue a degree in mathematical finance and later a Master's in Statistics.

He relished the community-driven, collaborative ethos at Waterloo. Given the sheer size of the Faculty, he was always able to find someone who shared his mathematical interests and he learned just as much from his peers as from his professors. Chief among the skills he acquired at Waterloo was the ability to effectively and succinctly convey complex ideas.



“The ability to communicate clearly is so important, especially when dealing with more abstract mathematical subjects,” says Avilez. “Ultimately, in the business world, your work is judged not just by its substance but also its style.”

This skill has helped Avilez thrive in his still young career, which has included stints at industry leaders such as Capital One, LinkedIn and, now, Squarepoint Capital, where he is a quantitative researcher. His job at Squarepoint allows him to apply his mathematical and statistical expertise in a variety of ways, from developing machine learning tools to devising investment strategies.

Since graduating from Waterloo, Avilez has made a point of giving back whenever he can, including generous gifts to the Centre for Education in Mathematics and Computing (CEMC). He admires the CEMC’s mission of making mathematics education fun and thereby sparking student’s interest in the subject. He also commends their work to level the playing field for people of underrepresented identities.

“There are people who are disadvantaged in STEM fields,” says Avilez. “And I think the CEMC does important work in helping bridge the inequality gaps that arise.”

Beyond his own giving, Avilez has found other ways to champion the CEMC’s cause. In 2023, he nominated the organization for a gift from the Squarepoint Foundation.

“There are people who are disadvantaged in STEM fields and I think the CEMC does important work in helping bridge the inequality gaps that arise.”

– JOSE AVILEZ

As a result of his application, the company made a significant contribution to the CEMC.

Ultimately, Avilez hopes his support for the CEMC can empower today’s students to pursue their interest in mathematics with confidence and enthusiasm, secure in the knowledge that the degree will open many doors for them.

“I want high school students to have a more linear path into mathematics than I did,” he said. “I think CEMC does a great job correcting some of the misperceptions about career prospects in mathematics by showing young students that there is so much you can achieve with a math degree.”



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