The Centre for Education in Mathematics and Computing

Unlocking potential through education

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UNIVERSITY OF WATERLOO

The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

Letters from the outgoing and incoming directors

Ian Vanderburgh
and Jen Nelson

When I started as Director of CEMC in July 2005, we were a small but committed team whose place within the Faculty and within the University was not terribly well-defined. Our team of about 15 people did good work that was focussed principally on enrichment activities at the secondary school level. We had a relatively new website, we were starting to experiment with online resources, and we ran a small number of in-person events, but our activity was mostly focussed on contests.

Fast forward to today and the CEMC is now a team of almost 45 who support an extensive range of activities for educators and students worldwide, both with curricular support and enrichment resources. Our contest operations are even larger than they were years ago, and we have added on to this: school visits (resurrecting a really successful part of the Faculty's history from the 1970s and 1980s), a broad suite of in-person interactions with educators and students, digital resources used by hundreds of thousands of students annually, an online Master's program, international partnership, and the list goes on!

While I have had the privilege of being Director for 20 years, the CEMC is first and foremost a team, and it is this team of smart, creative people that is the reason for the incredible growth in our activity and in our impact. From our faculty members who

teach our undergraduate and graduate students and are completely devoted to the CEMC's educational work, to our academic staff with previous careers in K to 12 education to our fabulous administrative staff who make everything happen in the background, we are a diverse team who believe in what you believe in: supporting young people and giving them opportunities to increase their interest, enjoyment, confidence, and ability in mathematics and computer science.

I write this letter with mixed emotions – after many wonderful years as CEMC Director, I am stepping down to take on a new role at the University level as Associate Vice-President in charge of Strategic Enrolment Management. I remain a faculty member in the CEMC and look forward to continuing to be involved, albeit in a less intense way, over the next several years. I am so proud of the work that the CEMC family has done. That family includes our faculty, our staff, the myriad educators in Canada and beyond who enable their students' involvement, and all of you – our supporters. The CEMC would not be what it is without every part of this family. Thank you for being past, present and future champions of what we do.

I could not be happier that my amazing CEMC colleague Prof. Jen Nelson is taking over as CEMC Director. Jen brings almost 20 years of experience in the CEMC and has led many of our programs at various points. I look forward to watching the CEMC continue to flourish under Jen's leadership!

IAN VANDERBURGH
OUTGOING DIRECTOR, CENTRE FOR EDUCATION IN MATHEMATICS AND COMPUTING

A lot has changed in the past 20 years, but the CEMC team's commitment to mathematics and computer science education has not. Whether through online resources, student workshops, educator development, or our contests, our dedication to providing high-quality resources that support and enrich the learning experiences of students and educators continues to guide our work. The entire CEMC team extends our deepest thanks to Ian for his vision and leadership in shaping the CEMC into what it is today: Canada's largest and most recognized mathematics and computer science outreach organization, with a reach that extends well beyond Canada.

This transformation could not have been possible without you either – our supporters. Thank you for the role you have played in enhancing mathematics and computer science education and for helping inspire the next generation of STEM leaders.

We look forward to continuing this important work and seeing the positive impact of our resources on students, educators, parents, and the wider community both within Canada and afar. From long-standing initiatives like the Auckland workshop, which recognizes excellence in our contests across Canada, to new and inspiring programs like the Mathematician Mosaic, which celebrates the diverse stories and backgrounds of mathematicians, to the expansion of our popular courseware to support Grade 4, 5, and 6 learners, to the growing reach of our work in Africa, in this report you'll read about some of the breadth and impact of the work going on in the CEMC, all in our mission of increasing interest, enjoyment, confidence, and ability in mathematics and computer science among learners and educators in Canada and internationally

JEN NELSON
INCOMING DIRECTOR, CENTRE FOR EDUCATION IN MATHEMATICS AND COMPUTING

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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
- The Mathematician Mosaic

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 girls and gender minorities
  - CS Escape
  - Seeing Possibilities and Rewards in Computer Science (SPARCS)
  - Think About Math! (TAM)
- Lloyd Auckland Invitational Mathematics Workshop

› CEMC Visits Schools

› Summer Courses

› Educator Development

- Summer Conference for Computer Studies and Mathematics Educators
- EFGH Marking

Empowering mathematical education across Africa: CEMC's growing impact

Lata Punetha

The Centre for Education in Mathematics and Computing (CEMC) is contributing to a growing movement of educational empowerment across Africa, where local educators and students are driving change in ways that reflect their unique goals and contexts. Through its outreach programs and partnerships across the continent, the CEMC continues to provide access to high-quality mathematics and computing resources, create contests, and support the professional growth of mathematics educators.

"Professor Ian VanderBurgh from the CEMC at the University of Waterloo started training in Kenya in 2023.The main objective was and still is to provide a variety of opportunities to learners to participate and excel in international competitions. It also aimed at developing learners' problem-solving skills and opening their global network."

– Daniel Kiilu

Ghana

Our work in Ghana has gained momentum with our partners in the country including the African Institute for Mathematical Sciences (AIMS) Ghana, Learning for Humanity, Ghana Education Services and select schools and universities. Focusing on educator development, empowering young women in mathematics and increasing students' overall interest in mathematics, we have continued to support our partners in initiatives like the:

› Helping Teachers Teach Mathematics Conference (HTTMC): In Spring 2025, 200 educators attended this conference in person and more than 300 educators attended it online. This conference partnership with AIMS is a part of the CEMC's commitment to provide training opportunities for mathematics educators in Africa.

› AIMS Girls in Mathematical Sciences program (GMSP): Comfort Mintah from the CEMC has been acting as the lead organiser of this program since 2021 and approximately 40 young women participate each year with many CEMC faculty giving talks and arranging for mentors to connect with and support the students throughout the year.

› AIMS Master of Mathematical Sciences for Teachers (MMST): Investing further into the education of math educators in Ghana, the MMST program has continued to grow, supporting 100 students. With 1,000 applications for this 2-year program, the demand is increasing. The CEMC supports 13 Skills Courses in year 1 and at least 6 Review Courses in the second year.

› Mathematical problem-solving workshops with the University of Education, Winneba: Scan the QR code below to watch this video of Comfort Mintah leading school visits in Ghana.

For more information on our work in Ghana, please visit:

youtu.be/0mrZ-CQBm6A

Rwanda

In Rwanda, the CEMC's partnership with AIMS Rwanda has enabled expanded collaboration across multiple regions. As part of this relationship, AIMS and the CEMC have grown their contest offerings, providing extracurricular opportunities for tens of thousands of students each year.

The Junior Rwanda Mathematics Contest (JRMC) has rapidly gained national momentum, with over 35,000 students participating in 2025 alone. Now seen as a cornerstone of Rwanda's mathematics enrichment efforts, the contest unfolds across three competitive rounds. The first round, held in January, welcomed all 35,000 participants, from which 10,000 advanced to the second round in February. By late April, 600 finalists competed in the third and final round. From this group, approximately 125 students were selected for summer camps, and 15 to 20 of them received specialized training to represent Rwanda at prestigious international competitions such as the International Mathematical Olympiad (IMO), the Pan-African Mathematics Olympiad (PAMO), and the East-African Mathematics Olympiad (EAMO). Notably, Rwanda's first-ever gold medalist at PAMO emerged from the inaugural JRMC in 2023 – a powerful testament to the program's impact and the strength of its partnership with the CEMC.

Kenya

In Kenya, the CEMC has continued to visit schools, and support mathematics education through their partnership with the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA). The CEMC's partnerships have helped establish the Kenya Mathematical Olympiad (KMO) as a beacon of mathematical excellence. In 2024, the KMO welcomed over 9,000 participants in its first round, with growing ties to competitions such as the East African Mathematical Olympiad (EAMO), the Pan-African Mathematics Olympiad (PAMO), and the International Mathematics Olympiad (IMO).

Last year, over 200 teachers participated in a series of online sessions led by experts from the CEMC, in partnership with CEMASTEA. These sessions were designed to equip teachers with effective problem-solving strategies in mathematics.

"I have had the privilege to take part in the Kenya Mathematical Olympiad (KMO) training, and I can attest that the KMO training, especially under the guidance of Prof. Ian VanderBurgh from the CEMC — has been truly transformative for me and for mathematics educators across Kenya. As a math teacher myself, I saw how the virtual teacher training transformed the way we engage with mathematical thinking. The sessions focused deeply on modern problem-solving methodologies, equipping us to design Olympiad style questions and foster robust student reasoning. Through their guiding examples, I gained confidence to implement interactive strategies such as problem-solving circles to engage students collaboratively in exploring patterns, formulating conjectures and validating solutions. These methods also empower me to explicitly develop critical thinking, problem-solving, self-efficacy and real-world application."

– Mercy Wainaina

Through sustained partnerships and a shared commitment to educational excellence in mathematics, the CEMC is proud to support a growing network of African educators and students who are shaping the future of mathematics across the continent.

Uniting students in mathematics

James Mason

Each year, the CEMC hosts the Lloyd Auckland Invitational Mathematics Workshop to bring together top contest performers from across Canada for a week of challenge and fun.

Since its inception in 1965, the Auckland workshop has brought together top performing students on CEMC math contests from across Canada for a week of challenge, problem-solving, and fun. Known formerly as the Canadian Mathematics Competition seminar, this workshop was renamed in 2010 as the Lloyd Auckland Invitational Mathematics Workshop in honour of Lloyd Auckland, a retired math teacher. Auckland volunteered with the CEMC (then CMC) since 1970 and taught one of the first mathematics classes held at the University of Waterloo.

This year, we had 70 students in Grade 11 participate and experience a unique enrichment opportunity that cultivates a national community of mathematicians. The workshop is structured to include engaging lectures, problem-solving sessions and social activities.

A central goal is also to foster meaningful connections among like-minded students. Participants often express how the experience allows their passion for mathematics to thrive – surrounded by a diverse community of peers who share their enthusiasm. The workshop is especially committed to reaching students who may have limited access to enrichment opportunities due to geographic barriers, creating a space where talent and curiosity can flourish regardless of location.

When asked about a highlight of their week, many participants enthusiastically pointed to the group problem solving sessions. Throughout the workshop, participants were divided into small groups and tasked with solving challenging problems collaboratively. These sessions not

"The Auckland workshop made me realise that there are amazing people and teachers out there that I haven't met yet. The workshop opened my eyes to a wider mathematics community that exists where I've made friends and feel more connected than ever before. At the workshop, I decided to pursue Math and come to Waterloo based on the lectures I attended."

– Sophia Sun, Former Auckland participant and Auckland Houseparent

"Being able to experience life in a university dorm enables students to have a valuable and exclusive look at the feel of being an undergraduate student. It also encourages students to develop even stronger connections outside of their academic sessions"

- Shane Bauman, Auckland Co-Director

only sharpened their problem-solving abilities but also fostered key communication skills, as participants worked to explain their reasoning and approaches to their peers. In many instances, participants took on the role of teacher guiding teammates through unfamiliar concepts, which further boosted their confidence. This activity helped participants build belief in their own abilities and learn from one another.

In addition to problem-solving sessions, there are daily lectures in the workshop that cover a wide variety of mathematics and computer science subjects such as The Pigeonhole Principle, The Prisoner's Dilemma, The Travelling Salesman Problem, Digital Images, Math in Space, and Computer Science Problem Solving, many of which are topics that may not have been a part of their high school curriculum. This exposure helps participants better understand the breadth of mathematics and computer science and learn more about their applications.

During the week, students have access to a campus residence where they share meals, play games, and engage in group activities. For many, this is their first experience of living with a roommate. Since the workshop is designed for seniors in high school, this glimpse into campus life is especially meaningful as they begin thinking about their academic futures. This experience offers not only a glimpse of university life but also expands their perspectives on the diverse career paths that mathematics can lead to.

By the end of the week, Auckland participants had formed strong connections that extended well beyond the workshop itself. Since the conclusion of the 2025 edition, students have continued to stay in touch remotely – even organizing virtual game nights to reconnect and share their enthusiasm for mathematics. These ongoing relationships speak to the lasting impact of the workshop, which not only nurtures mathematical talent but also builds a vibrant, supportive community that endures long after the final session.

Student quotes

"The best part of the workshop was the computer science lecture. It was insanely enlightening and interactive. Loved every bit of it!"

"Everyone here is so knowledgeable and passionate and I wish we got to learn even more!"

"I had the opportunity to meet a lot of new friends and learn some techniques for problem solving."

"I'm glad I met new people and made friends who are also passionate about math and problem solving. Touring a university was a really cool opportunity as well!"

"The workshop was so fun, and I learned a lot throughout the experience. I met some really cool and kind people who inspire me to keep working hard when studying math so I can see them again. "

"The best part was all the people I met and the activities that I got to do with them. Being able to talk with people similarly interested in math was amazing."

The Mathematician Mosaic: honouring diverse stories in STEM

Lata Punetha

In Fall 2024, the Centre for Education in Mathematics and Computing (CEMC) launched *The Mathematician Mosaic*, an initiative aimed at recognizing and celebrating the contributions of a diverse set of mathematicians across a wide range of disciplines. This project seeks to inspire students to explore and research the stories of influential figures in mathematics and computing – notably those from under-represented backgrounds. Through the creation of biographical posters, students spotlight the lives, careers, and stories of unsung individuals who have made significant impacts in fields ranging from pure mathematics to data science.

"I hope that our first batch of highlighted posters not only showcases the diversity within our field and the challenges many individuals have faced but also serves as an opportunity for students to see themselves represented in mathematics."

– Sachin Kotecha, Co-Lead,
The Mathematician Mosaic Project

"Through this project, I myself have learned about some new mathematicians and their contributions to STEM. I hope that by diving into the journeys of other mathematicians and learning about how these role models have overcome adversity, students realize their own potential to succeed in STEM."

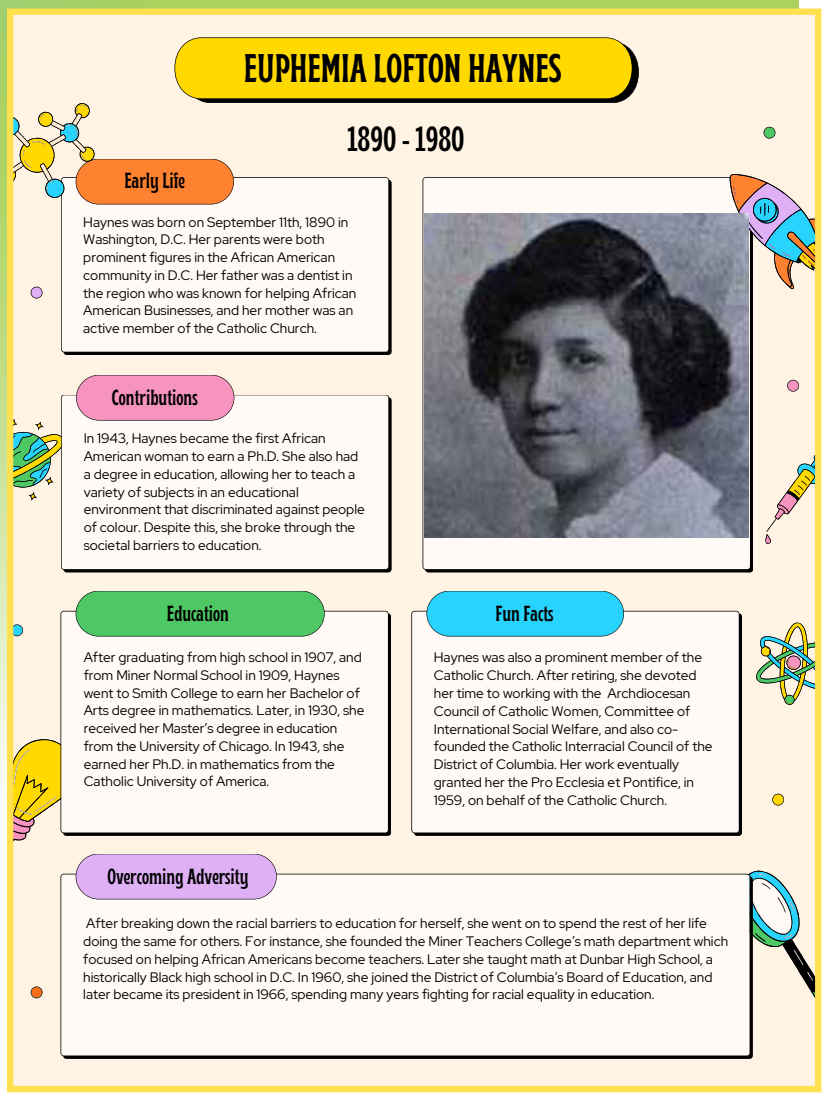
– Anila Yadavalli, Co-Lead, The Mathematician Mosaic Project

Our plan is that each fall, students from Grades 1 to 12 will be invited to participate by submitting posters that highlight mathematicians who have overcome adversity, pursued unique career paths, or belonged to marginalized communities. Whether working individually or in groups, participants will bring distinctive and remarkable stories to life, with selected posters featured on the CEMC website.

In the project's first year, we received over 80 thoughtful submissions from students around the world and are proud to showcase the 18 posters chosen for publication on the CEMC website. These posters included stories of mathematicians from China, Egypt, Hungary, India, Iraq, Nigeria, Russia, UK and USA. Through this creative and educational celebration of mathematicians, we hope students will see themselves in these powerful stories – and feel inspired to pursue their own paths in STEM.

"I was truly impressed by the incredible posters the students created. Their submissions exceeded our expectations, showcasing both creativity and depth. I discovered so many fascinating facts about inspirational mathematicians, making the experience even more enriching."

– Fiona Dunbar, Co-Lead, The Mathematician Mosaic Project



To view the posters that have been selected for this year's Mathematician Mosaic initiative, please visit:

cemc.uwaterloo.ca/resources/mathematician-mosaic

Sparking interest in computer science

James Mason

Each year, the Centre for Education in Mathematics in Computing (CEMC) hosts the SPARCS (Seeing Possibilities and Rewards in Computer Science) workshop to inspire Grade 9 and 10 students from gender identities underrepresented in the field to explore the exciting world of computer science.

Despite ongoing gender disparities in STEM, the CEMC and the University of Waterloo remain deeply committed to fostering equity. For over 20 years, the CEMC has offered workshops and programs designed to support students from gender identities underrepresented in mathematics and computing. These initiatives aim to build confidence, spark curiosity, and demonstrate that success in STEM is not only possible – but within reach. By providing access to enriching learning experiences, valuable resources, and a diverse community of peers, we strive to create an environment where every student feels seen, supported, and inspired.

This year's SPARCS workshop saw 39 students in Grades 9 and 10 participate throughout the week in engaging lectures and hands-on activities. Students came from across Canada to participate in this workshop and foster an interest in computer science. Some students have limited access to computer science resources, so this workshop helps to introduce them to new learning opportunities they may not have experienced otherwise.

"Having such a wide variety of both topics and mentors helps students relate to computer science experts and understand the nuances involved in further pursing the field."

– Valentina Hideg, SPARCS Co-Director

"Participants share with us after the workshop that they feel more knowledgeable and more confident. They also say that they can now visualize themselves working in the field whereas before it was not something they knew how to picture."

– Sarah Chan, SPARCS Co-Director

SPARCS explores topics such as quantum computing, virtual reality, artificial intelligence, digital hardware, and programming. The diversity of content among sessions shows participants the breadth of computer science's real-world applications. These sessions are led by Waterloo faculty and graduate students. Some of these sessions, particularly quantum computing and artificial intelligence, focus on demystifying these big concepts. Participants learn how these tools and technologies could either help or harm us. In the case of digital hardware, participants work under the hood of a computer to better understand how they operate. In programming, students use their logical thinking skills to facilitate problem-solving. Participants also take part in an undergraduate panel, where current University of Waterloo computer science students of various backgrounds, fields of study, and interests share their experience as a computer science student in university.

During their week at SPARCS, participants stay in a University of Waterloo campus residence and alongside their academic learning they participate in various social activities including a trivia night and a talent show. For many participants, SPARCS is their first experience of university life outside of their homes and being able to stay in campus residence together with others helps to build their independence and encourages meaningful relationships. They eat meals together and spend time socializing after workshops, which fosters a sense of belonging.

By the end of the week, participants have made lasting connections with other students and faculty at Waterloo, making them a part of a larger community of like-minded individuals. Participants in the workshop come with varying levels of computer science experience and interest and often are unsure if they want to pursue a career in the subject. The workshop expands their views regarding the breadth of opportunities that computer science can offer.

A group of students that started out hesitant and unsure of whether computer science is right for them were excited to pursue it further by the end of the week. The positive response that students have towards computer science because of the SPARCS workshop bodes well for a future with more diversity in the field. The SPARCS workshop will continue encouraging students to explore the many disciplines that computer science offers by providing more learning opportunities and access to a supportive community.

Student quotes

"We were able to learn different concepts relating to the field of computer science and received a lot of real life advice."

"It was fun and interesting with new things to learn everyday."

"I don't think I ever would have actually believed I could pursue big opportunities like this without coming here first!"

"I'm so lucky to have had this opportunity, and I really want other future girls to get this opportunity too!"

"I enjoyed how the workshop is meant to help young women interested in computer science feel comfortable and take that leap to get into the topic despite it being mostly male dominated I honestly felt more comfortable having this opportunity as one of my first looks into computer science rather than being one of the only girls in a class. Opportunities and resources like this are needed for girls who want to try out computer science, but feel too nervous to do it with how women are in it. I know these opportunities are needed because I was one of those people."

Update on the expansion of elementary CEMC resources

Lata Punetha

Over the past year, experts at the CEMC have been actively developing plans to expand their elementary-level resources. This includes broadening the CEMC Courseware to offer lessons and support materials tailored for Grade 4, 5, and 6 learners and educators. In addition, the CEMC Visits Schools program is being extended to reach elementary schools, ensuring younger students have access to engaging mathematical enrichment.

School visit program

The elementary school component of CEMC Visits Schools program has experienced significant growth this year. This program has been focused on helping test our activities and lessons, which ultimately may be a part of the elementary courseware. We have also been able to highlight some of our existing resources, such as the Problem of the Week and the Beaver Computing Challenge, to Grade 5/6 educators – further extending the reach of our enrichment opportunities. Many educators are returning for repeat visits, and it has been exciting to see students recognize and remember us from previous years. We have also started building new connections with educators across different grade levels, successfully introducing several intermediate educators to our Grade 7/8 school visit program.

Courseware design and development

Designed with long-term impact in mind, the elementary courseware will support students in Grades 4, 5, and 6, offering age-appropriate content that builds progressively across grades. This courseware will include lessons which consist of five carefully structured components to support a wide range of learners:

› **Warm Up** activities that are open-ended and inclusive, ensuring every student can engage meaningfully from the start.

› **Let's Learn** videos (under 5 minutes) that clearly and visually explain key concepts.

› **Check Your Understanding** tools – interactive GeoGebra-based questions that are algorithmic, providing personalized feedback and repeated practice.

› **Let's Practise** questions with built-in scaffolding to support differentiated instruction.

› **Take It Further** challenges to promote critical thinking and deeper exploration.

In addition to these digital components, every lesson will include printable worksheets that balance foundational skills with deeper problem solving, as well as games that offer a fun opportunity to practise math skills. Investigations, like our exploration of the Kotavik Number System in the Place Value unit, further support cross-topic connections and cultural relevance.

As a part of the content creation journey, our team engaged with 14 educators from multiple Ontario school boards to showcase the lesson prototypes for our newly developed courseware. Educators were encouraged to share not only what they thought would work well but also any concerns or limitations they foresaw in a classroom setting. Positive feedback highlighted several strengths of the courseware, including:

› Prompts that help students independently navigate challenging questions.

› A user-friendly layout with a thoughtful balance of open-ended and knowledge-based questions.

› A flexible lesson structure that supports whole-class, small-group, and independent learning.

› Versatility in how the content can be integrated into various teaching approaches.

Educators requested the following:

› The importance of aligning with board-mandated long-range planning.

› A desire for easy access to games, worksheets, and investigations outside of the full lessons.

› Consideration of reading levels and the potential for students to feel overwhelmed by volume of text.

Our team took this feedback seriously and made necessary amends in response.

Importantly, we view the courseware as a supportive resource, not a replacement for educators. Our aim is to empower educators with high-quality, flexible materials that they can use to enhance classroom learning in ways that best suit their students' needs. When launched, our support materials and training will emphasize this vision: courseware as a toolkit for educators, not a self-contained program for students to navigate alone.

Testimonials

Question: How would you describe your overall impression of the courseware prototype?

YAY... amazing ! Way to go... this is a great start... so many great components... and ideas embedded...

I am impressed and grateful for a helpful, well thought out platform and that you are including teacher feedback and suggestions.

I'm excited about it. It's well organized, and the fact that it is open for everyone is amazing.

Awesome! Kid friendly! Great resource for teachers.

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THE CENTRE FOR EDUCATION IN MATHEMATICS AND COMPUTING
200 UNIVERSITY AVE. W., WATERLOO, ON, CANADA N2L 3G1

cemc.uwaterloo.ca