ONTARIO ASSOCIATION FOR MATHEMATICS EDUCATION
ASSOCIATION ONTARIENNE POUR L'ENSEIGNEMENT DES MATHÉMATIQUES

Effective Use of Digital Technology in Mathematics Education

OAME/AOEM Position Statement

June 2025

The goal of each OAME/AOEM Position Statement is to outline OAME/AOEM's beliefs on issues surrounding math education by providing transparency and guidance to those involved with mathematics education in Ontario. Any clarification regarding a position, or how to proceed in accordance with it, can be brought to the attention of the OAME/AOEM Executive Committee.

Focal Question

How does OAME/AOEM support, promote and enhance the use of technology in classrooms in ways that are pedagogically sound, equitable, responsive, and reflect the ever-changing nature of technology?

Summary

There is a meaningful place for technology within the mathematics classroom. It can be used by students to develop their mathematical proficiency, as well as by educators for planning meaningful activities.

With respect to learning mathematics, technology can be used to:

- help students visualize and make sense of mathematical concepts,
- help students develop a productive disposition toward mathematics, and
- enhance students' ability to process and communicate mathematical thinking.

With respect to teaching mathematics, technology can be used to:

- differentiate instruction,
- engage and excite students in learning math, and
- support academic honesty.

OAME/AOEM supports the effective use of any technology in mathematics education, provided the technology augments - not replaces - student thinking. This organization commits to modelling ethical and responsible use of technology in our publications and teacher support materials.

Use of Technology in Mathematics Learning

Mathematical proficiency goes beyond computational skills and the application of algorithms. It includes conceptual understanding (visualizing and making sense of the math), productive disposition (persevering in learning), and adaptive reasoning (including providing explanations and justifications) (National Research Council, 2001). As an instructional tool, technology can be used to help students develop mathematical proficiency in several ways:

1) Technology can be used by students to help visualize and make sense of mathematical concepts. Conceptual understanding, or an integrated and functional grasp of mathematical ideas, includes visualizing and making connections with prior knowledge (National Research Council, 2001). In some instances, such as using number lines and arrays, the visual representations are the math (Lambert, 2024). Understanding of mathematical concepts often begins with students using concrete materials, which may include virtual, dynamic manipulatives (NCTM, 2002). Digital tools can be used by students to interact with multiple representations. Virtual manipulatives, graphing software, and geometric tools can all be used to explore the dynamic nature of mathematical relationships, and make mathematics accessible to all students. Through thoughtful discussion, questioning, and consolidation, teachers can highlight connections between various digital, symbolic, and concrete representations.

However, technology is not a substitute for conceptual understanding of basic mathematical skills. For example, technology can perform calculations, but students still need to learn the meaning and application of operations such as addition, subtraction, multiplication, and division. When students engage with math in various contexts and make connections between operations through problem solving, reasoning, and proving, they are better able to understand how, when, and why each operation is used. These connections to the Mathematical Process Skills listed in the Ontario Mathematics Curricula (elementary, secondary) are foundational to learning math and should be developed alongside the use of technology.

2) Technology can help students develop a productive disposition toward mathematics. Productive disposition includes the belief that a steady effort in mathematics is rewarding, as well as the ability for students to see themselves as learners and doers of mathematics (National Research Council, 2001). Where computation is a barrier to completing a complex sequence of steps, technology such as a computer algebra system can provide a scaffold for students. In addition, students can use technology to compare a computer-generated solution with their thinking about a problem *after* they have engaged in the problem-solving process and found a solution. This then becomes a means to make sense of different solutions. Digital tools can also be used to facilitate opportunities to engage in complex tasks by gathering primary and secondary data. This can include relevant and engaging tasks that address issues in local communities and around the world and support the belief that students can make a societal impact using math.

While technology might be used for repeated practice of skills to improve computational fluency (and hence, improve students' confidence as doers of mathematics), teachers should be judicious in the frequency with which they assign such tasks. Targeted practice goals can be revisited and adjusted frequently, using technology to maintain an appropriately high level of expectation for individual students. If the primary focus of a technological tool is advancing levels or collecting rewards at the expense of deep thinking, the use of the tool should be reconsidered.

3) Technology can enhance students' ability to process and communicate mathematical thinking. Adaptive reasoning, which includes students' ability to explain and justify their thinking, can be facilitated through the use of technology in the classroom (National Research Council, 2001). Digital tools, such as a collaborative virtual whiteboard space, can offer students the opportunity to work with their peers to identify multiple strategies to approach a problem and discuss questions to clarify the task. This allows students to make connections between diverse perspectives when problem solving, as well as receive feedback from other learners. Students can also use technology as an aid when providing both informal and formal justifications of their process and solutions. Teachers can use digital tools to help create a classroom culture of collaboration, with a focus on making connections among concepts and situations.

While access to technology allows students to share technologically generated solutions with their classmates and teachers, it also makes it easier to misleadingly present this work as their own. When emphasis is placed on the initial thinking and the process of collaboration during problem-solving, it becomes more difficult for students to replace these processes with solutions they did not create themselves.

Use of Technology in Mathematics Teaching

Teaching is a complex process which involves designing instructional experiences that connect to, and apply, students' background knowledge. To do this effectively, educators need both deep mathematical content knowledge and pedagogical strategies (Loewenberg Ball et al., 2008). Technology has several uses when it comes to teaching, including the ability to make instruction easier to plan, learning easier to assess, and lessons more engaging.

1) Technology can be used to differentiate instruction. Students have different learning needs due to their diverse backgrounds, as well as varying prior knowledge and experiences with mathematics. Technological tools can help educators with determining and meeting such needs. Responding to students' math learning needs also involves a deep understanding of curricular concepts and how they develop. Technology can support teachers in deepening their math content knowledge for teaching through the vast array of interactive teacher guides, online simulations, and developmental continua. Technology can support teachers to be more precise in their planning and respond in a timely manner to student areas of need.

Technology can provide targeted instruction and practice opportunities to help close gaps in student knowledge and reinforce learning. However, technology is not a replacement for educators' thinking or being responsive to students' needs, nor should it be applied indiscriminately and simply because it is available. With digital practice tools, there is the potential to collect large amounts of assessment data. It is nonetheless important to triangulate balanced assessment data between conversations, observations, and products from a wide range of sources when making instructional decisions and

evaluating learning. In addition, when technology is used as a one-size-fits-all solution for all learners, opportunities for differentiation may be overlooked.

2) Technology can be used to engage and excite students in learning math. Gamification of mathematics learning has been shown to increase engagement, improve problem-solving skills, and reduce math anxiety (Jutin & Maat, 2024). While technology can be used by teachers to gamify the learning process, the primary purpose of any technology or digital tool in a math class is to promote and facilitate mathematical thinking and reasoning. As such, the strategy of gamifying with technology should not be misused as a classroom management technique or as a tool that keeps students quiet, busy, and working alone. Furthermore, students may feel isolated when technology is used primarily to engage students in independent practice.

3) Technology can be used to support academic honesty. Teachers play a leading role in guiding students to understand the difference between technology augmenting versus replacing student thinking. For example, teachers can model how to assess the reasonableness of an answer and then use online tools to check solutions and receive immediate feedback. Similarly, online graphing tools can be used to confirm a student's initial sketch of a function. However, teachers are understandably concerned about the potential use of technology by students to misrepresent work and thinking as their own. Placing a greater emphasis on the learning process rather than final products shifts the nature of students' utilization of technology from deception to development.

Regardless of how an educator chooses to use technology in their classroom, they have a responsibility to ensure that technology used in mathematics teaching and learning is accessible to all students, regardless of socioeconomic status or other demographic factors. Unequal access to technology amongst students can exacerbate existing inequities and harm student learning outcomes.

The Role of OAME/AOEM in Supporting Math Educators' Use of Technology

OAME/AOEM supports the effective use of any technology in mathematics education, provided the technology augments — not replaces — student thinking. Teachers considering the use of any form of technology, from calculators to generative artificial intelligence, must be intentional in its purpose to support specific learning goals. OAME/AOEM commits to supporting teachers with ongoing learning to ensure technology use in classrooms enhances students' abilities to apply mathematical processes.

OAME/AOEM is positioned to play a lead role in technology use within mathematics education in Ontario. The organization commits to modelling ethical and responsible use of technology in our publications and teacher support materials. In addition, through the development of chatOAME, an AI

chatbot designed to support Ontario mathematics teachers, OAME/AOEM is leading the way in leveraging artificial intelligence ethically and responsibly to enhance teacher practice. Finally, OAME/AOEM calls on school boards to invest ample time and resources towards teacher training so that all mathematics educators are supported to meaningfully integrate technology into student learning experiences.

References

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