

# Computational Thinking in Mathematics Education Symposium

**13-15 October 2017**  
**Faculty of Education**  
 University of Ontario Institute of Technology



SSHRC CRSH



There have been numerous calls in public media recently from academia, industry, and non-profit and government organizations for students across all levels of education to study and develop competencies in computational thinking. In addition, there has been a flurry of non-profit and commercial development of out-of-school tools for engaging children and adults with computational thinking using screen-based environments, such as block-based computer programming environments (see Figure 1), and digital tangibles, such as programmable robots and circuits (see Figure 2). With the parallel development of apps for mobile devices, opportunities for computational thinking experiences are becoming accessible to a wide audience.

Our *Computational Thinking in Mathematics Education Symposium*, held on 13-15 October 2017 at University of Ontario Institute of Technology (UOIT) in Oshawa, aimed at discussing computational thinking as a mathematics curriculum focus, both from a research and school integration perspectives. With its 45 participants registered from 6 Canadian Provinces (Alberta, British Columbia, New Brunswick, Ontario, Quebec, and Ontario), and 7 countries (Australia, Brazil, Canada, Mexico, USA, Iran and Jamaica) from academia (18 academics, 16 student researchers and students, 1 post doc), school boards (5 mathematics education leaders and teachers), ministry of education (3 officers), and other organisations (2) the symposium achieved its goals through the structure of small working groups employed in five symposia previously hosted at Western University (2003-2006, 2015). Three themes were deliberated upon:

1. A curriculum focus on the integration of computational thinking and mathematics teaching and learning in education settings.

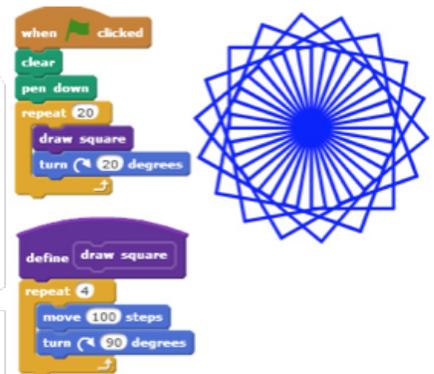


Figure 1. Squares pattern in Scratch.

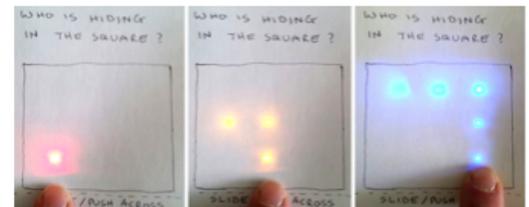
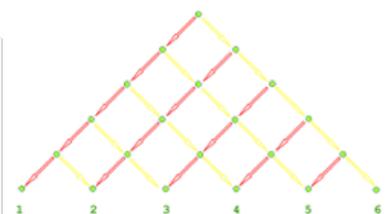


Figure 2. Sticker-based circuits used to model the first 3 odd numbers (1, 3, 5) "hiding" in a 3x3 square.

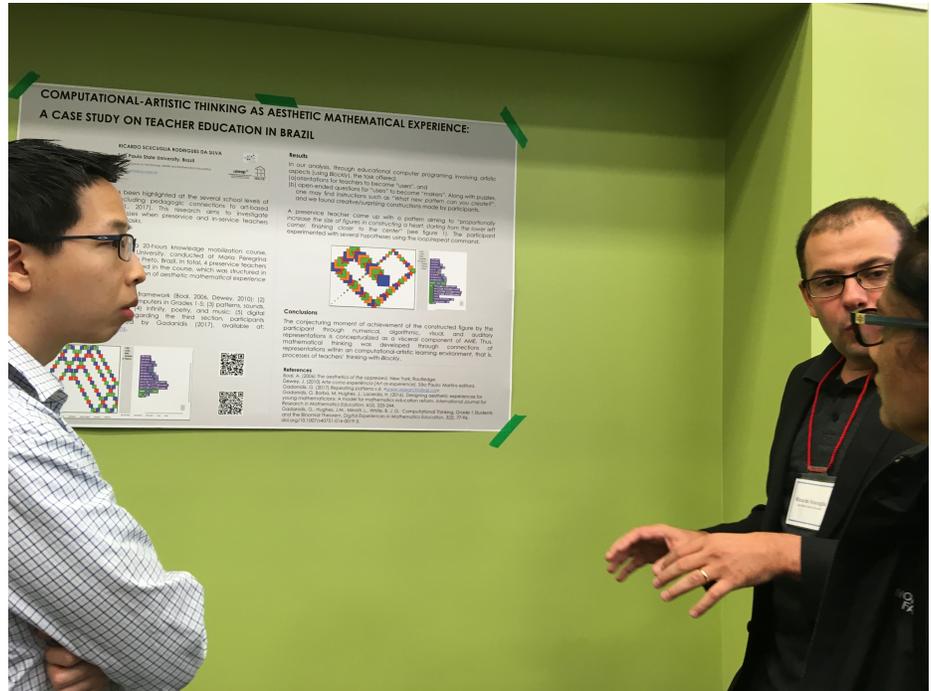


Start at top of the path  
**Repeat until the bottom of the path**  
 Toss coin  
**If coin = RED**  
     Take 1 step on RED path  
**Else**  
     Take 1 step on YELLOW path  
**End If**  
**End Repeat**

Figure 3. Binomial Theorem in Grade 1.

2. A research-based focus on the interplay between the affordances of computational thinking and mathematics thinking.
3. A pedagogy-based theme on the nature of exemplary tasks, pedagogical models, instructional materials and resources, and assessment practices for computational thinking.

In addition, two keynote presentations enriched our discussion: Prof. Lyn English (Australia) spoke about learning innovation in STEM, and Dr. Michelle Wilkerson (USA) spoke about computational integration to support expression, refinement, and collective knowledge in classroom communities. The keynote addresses were open to the public, and the keynote speakers attended the Symposium in particular by participating in working group deliberations. A poster session (6 posters) held on Saturday also provided further thoughts for the working groups' deliberations. Participants ended each day of the symposium with an informal—a welcome reception on Friday and an informal gathering on Saturday—to continue the conversations started during the day part of the symposium.



During the symposium, participants tweeted using #CTMath about themes such as “what computational thinking means” (K. Bairos tweeting for KNAER-RECREAE) and “low floors, high ceilings, wide walls and conceptual surprises-Gadanidis et al., 2016” (B. Zoras). But the discussion started earlier on the symposium blog. Here are some anecdotes:

“My experience in working with students suggests that programming works best when both paper and pencil and computer are used when/as appropriate. Before starting to code, students need to make sure that they internalize the problem they are working on, as well as understand the program design—in particular, the algorithm(s) they are about to use. Students need time to learn how to prepare (“repackage”) a math problem for exploration using programming. Visual approaches, such as using flow charts, turn out to be extremely helpful.” (L. Miroslav)

“I agree with the points you make, and I always have pencil and paper for designing and sketching as part of my STEM activities. There are, of course, lots

of rich computational thinking and early coding experience for young children before they face a computer screen.” (L. English)

My big interest is the relationship between my classroom objectives, which I call mathematical thinking, and our work here with computational thinking. This question is very prominent in the posters of Laura Broley and Natalia Vasilyeva. There is no coding in my high school activities but technology certainly allows me to give them tasks that would otherwise be hard to describe. For example, a recent grade 12 trigonometry task is to construct the following Desmos animation: <https://www.desmos.com/calculator/bswucqgidy> Could do that with GSP as well of course, and could do it with Python. Each of these uses more or less amounts of coding. I'd like to think CT was involved in all three approaches. (P. Taylor)

Finally, early on Friday, a Maker Day for Teachers event, jointly organized with UOIT Steam3-D Lab- [janettehughes.ca/lab/](http://janettehughes.ca/lab/) and the symposium organizers, engaged 141 teacher candidates and 13 educators from the area as well as 15 symposium participants in the broader area of 'making'. The event consisted of 2 whole group and 9 breakout sessions.



For symposium proceedings visit <http://ctmath.ca/computational-thinking-in-mathematics-education-symposium/>. For Streaming of Lyn English's Keynote see <http://bit.ly/2wM7coz> and Michelle Wilkerson's Keynote see <http://bit.ly/2y9rSuO>.

The symposium was part of a 2016-2018 SSHRC Partnership Development Grant (PDG) project, involving 9 researchers from: Brock, Laurier, McMaster, Queen's, SFU, UOIT, and Western. Consequently, on the last day of the symposium, Sunday, the symposium was followed with a PDG meeting to discuss further development of the partnership on computational thinking in mathematics education that would take form as a major collaboration to which more partners including international researchers and with Canadian industry partners would be added.

One participant captured the success of the symposium in her tweet: "what a weekend of thinking about #computational thinking and #math! Thank you to the organizers of the #ctmath symposium!" (L. A. Floyd).

The success of the symposium is attributed to the generosity of Fields Institute for Research in the Mathematical Sciences (Fields) which funded 75% of the symposium budget. It was also sponsored by Faculty of Education, University of Ontario Institute of Technology (UOIT); Faculty of Education (Western Education), The University of Western Ontario; Brock University, and the SSHRC partnership development grant on Computational Thinking in Mathematics Education: [www.ctmath.ca](http://www.ctmath.ca); and supported by Mathematics Knowledge Network: <http://mkn-rcm.ca>, NSERC, and hosted by University of Ontario Institute of Technology (UOIT).

We thank all symposium and maker day participants for the enriching discussions.

The symposium and maker day organizing committee: Immaculate K. Namukasa (Western), Chantal Buteau (Brock), George Gadanidis (Western), Janette Hughes (UOIT), Donna Kotsopoulos (Huron University College)

