Computational Thinking in Mathematics Education Poster Session

October 14th, 2017
Faculty of Education
University of Ontario Institute of Technology
3-4 pm Poster/Project Display & Coffee

Schedule

1. Laura Broley (Concordia University)

Title : "Computational" and "Mathematical" Thinking: Exploring Difference and Interdependence

Abstract: In reading some of the recent definitions given for "computational thinking", I find myself wondering (as many others have) about how this kind of thinking is related to what has been defined, with a rivalled multiplicity, as "mathematical thinking". Depending on the definitions chosen, one possible difference between the two is that "computational thinking" is linked to the use (either immediate or eventual) of a computer. When we picture students engaging in "computational thinking", they are typically not alone: they are thinking in front of and *with* computers. We may even say, in some sense, that the computers are doing part of the "thinking" for them! Indeed, the powerful way in which computers extend mathematicians' capabilities (e.g., for calculation, experimentation, simulation, or visualization) has led to novel areas, approaches, and concepts in mathematics, providing a convincing case for implementing computer activities in mathematics classrooms. But the fact that computers can "think with/for us" does not mean that they "think like us", if we even know how or what they are "thinking" in the first place! Several scholars have commented on the striking resemblance of "computational thinking" and "mathematical thinking" (for example, in their logical structure), providing another case for inviting mathematics students to engage with computers. At my poster, I would instead like to focus on difference; not as a discouraging constraint, but as another source of rich learning opportunities for mathematics students. Some activities from a scientific computing course will serve as examples for discussion.

2. Steven Khan (University of Alberta)

Title: Debugging a halting problem: Two cautionary cases.

Abstract: In this poster I present my reflections on two experiences with engaging with mathematics and computational thinking that have caused me to halt and re-examine my goals and that of a math and CT agenda from the earliest grades. The first case, make kin with robots, presents narrative observations of a parent and daughter playing with Cubetto (an early years robot) together with my own reflections on how my own daughter and I interacted with the robot. I propose some ethical considerations for working with young children and robots from the literature. The second case is a re-examining of my motivations for proposed culturally situated and respectful computational thinking activities in the absence of engagement with cultural practitioners and in the context of ongoing concerns about cultural appropriation and discourses of power in mathematics education.

3. Marja Miller and Immaculate Namukasa (University of Western Ontario)

Title : Computational Thinking Tool as a Platform to teach Mathematics

Abstract : As society becomes more technology driven, teaching our students computational thinking skills are essential in preparing them to be creative, innovative and develop novel solutions. Computational Thinking (CT) tools can also be used to teach and learn mathematics and to make abstract concepts more tangible (Xu, 2005). This project aimed to answer the following research questions: What might computational thinking integrated with mathematics thinking look like in K-8 classrooms? What its affordances, enablers, and constraints? What are the students' attitudes towards it? The researcher worked with eight K-8 class teachers in five schools implementing CT and Math activities in the classroom. These activities can be considered "warm" math tasks because it provides "non-traditional ways of teaching math with variable entry and non-standard rich learning tasks that go beyond mere practice and procedure" (Namukasa, Gadanidis, & Cordy, 2009, p.49). The researcher collected field notes, teacher surveys, audio records of conversational interviews with teachers as well as photo data of students' work and teachers' presentations. The following CT tools were used in the activities: Osmo Coding, KIBO, Cubbetto, Scratch, Scratch Jr., Sphero, MBot, MaKey MaKey and math apps. Students were enthusiastic and engaged in the coding/math activities, and seemed to enjoy themselves. Use of CT tools in teaching and learning mathematics appeared to create a more conducive learning environment where K to 8 students, for instance, were willing to make mistakes, trouble shoot and problem solve.

4. Ricardo Scucuglia Rodrigues da Silva (Sao Paulo State University, Brazil)

Title : Computational-artistic thinking as aesthetic mathematical experience:
a case study on teacher education in Brazil

Abstract: Computational thinking has been highlighted at the several school levels of mathematics education, including pedagogic connections to art-based activities (Gadanidis et. al, 2017). This research aims to investigate mathematical thinking processes when preservice and in-service teachers explore computational-artistic tasks. The scenario was designed as a 20-hours knowledge mobilization course, organized by Sao Paulo State University, conducted at Maria Peregrina Catholic School, in Sao Jose do Rio Preto, Brazil. In total, 4 preservice teachers and 6 in-service teachers participated in the course, which was structured in five sessions focusing on the very notion of *aesthetic mathematical experience* (AME) (Gadanidis et. al, 2016). The sessions were: (1) theoretical framework (Boal, 2006, Dewey, 2010); (2) colors, music, embodiment, and computers in Grades 1-5; (3) patterns, sounds, and computers in Grades 6-9; (4) infinity, poetry, and music; (5) digital mathematical performance. Regarding the third section, participants investigated a task designed by Gadanidis (2017), available at: www.researchideas.ca/patterns/repeating-patterns-tutorial.pdf. In our analysis, through educational computer programing involving artistic aspects (using *Blockly*), the task offered (a) orientations for teachers to become "users", and (b) open-ended questions for "users" to become "makers". Along with puzzles, one may find instructions such as "*What new pattern can you create?*", and we found creative/surprising constructions made by participants. For instance, a preservice teacher came up with a pattern aiming to "proportionally increase the size of figures in constructing a heart, starting from the lower left corner, finishing closer to the center" (see figure 1). The participant experimented with several hypotheses using the *loop/repeat* command. The conjecturing moment of achievement of the constructed figure by the participant through numerical, algorithmic, visual, and auditory representations is conceptualized as a visceral component of AME. Thus, mathematical thinking was developed through connections of representations within an computational-artistic learning environment, that is, processes of teachers' thinking-with-*Blockly*.

5. Nathalie Sinclair and Victoria Guyevskey (Simon Fraser University)

Title : Geometric Coding Environment: Integration of Computational Thinking and Mathematics in Primary School

Abstract : The purpose of this study was to develop and research the effectiveness of geometric coding environment. This research project was aimed at studying the use of dynamic geometry software (The Geometer's Sketchpad) as a spatial programming language at the primary school level. We conducted a two-month classroom intervention with grade 2/3 students, experimenting with computational thinking (CT) activities centrally involving geometry, spatial reasoning and the use of dynamic geometry environment (DGE). In our experiments, we were interested in how DGE/CT approach gives rise to concepts in both mathematics and programming. We tried to design tasks that would combine CT and geometry, and we wanted to see (1) what the students would learn and (2) what the effect of combining domains would be (how the concepts would change). In our tasks, we examined dynamic circle as a tool, which enables students to determine whether the two segments are of the same length, and also enables them to construct two segments of equal length. It involved creating a procedure when building a "stick man", and testing if it worked. After the series of lesson, a number of students were interviewed in order to help us gain understanding into the coding process that students undertook, and see to what extent instances of computational thinking are present in their cognitive processes. Our finding is that many CT concepts can be taught using DGE, and that there are good reasons to use DGE to develop spatial reasoning and learn school geometry. The procedures students carried out followed sequence of steps consistent with computational thinking: develop a procedure, carry out the procedure, correct the procedure if it does not work. This seems to provide a good ground for Math/CT interdisciplinary integration.

6. Natalia Vasilyeva (Concordia University)

Title: Computational Approach in Solving Problems Requiring Mathematical Investigation

Abstract: It is a common approach among students to use empirical means or just check a number of examples in order to prove a general statement instead of constructing a deductive proof (Balacheff, 1988; Harel and Sowder, 1998; Weber, 2001). Instructors in proof-oriented courses warn students not to "prove by example." However, mathematicians highlight that using examples plays important role in conjecturing and proving (Thurston, 1995; Alcock, 2004).
The poster will present some results from a study concerning how undergraduate students validate the results of their mathematical thinking or problem solving. The participants in this study were undergraduate students enrolled in "Introduction to Mathematical Thinking" course at Concordia University. In particular, we analyzed students' written solutions of a problem involving mathematical investigation (the haggling problem). This analysis evidenced that there are two main approaches to solving the haggling problem. A computational approach is characterized by an exploration of numerical examples that leads to conjecturing and generalizing. An analytical approach is characterized by an exploration on the sequence of coefficients and using algebraic formulas. It will be discussed how students use numerical results for understanding the task, conjecturing, justifying and checking. The poster will also include suggestions on how computational approach can be applied in teaching proofs and problem solving to obtain intuitions and ideas.

Organizing Committee

Immaculate Namukasa (Western), Chantal Buteau (Brock), George Gadanidis (Western), Donna Kotsopoulos (Huron University College), Janette Hughes (UOIT)