CANADIAN MATHEMATICS EDUCATION STUDY GROUP

40TH ANNUAL MEETING

JUNE 3TH TO JUNE 7TH, 2016

ANNIVERSARY THEME:

CELEBRATING THE PAST, INSPIRING THE FUTURE

ANNOUNCEMENT AND PROGRAM

We're happy to welcome you to Queen's University for the 40th Annual Meeting of CMESG/GCEDM, which begins at 6:45 pm on Friday June 3rd and ends at 12:30 pm on Tuesday June 7th.

From the modest roots of a tiny local college founded in 1841, Queen's has grown into a dynamic national institution renowned for an exceptional student learning experience and prominence as one of Canada's leading research-intensive universities. Located in Kingston, Ontario, Canada, it is a mid-sized university with several faculties, colleges and professional schools, as well as the Bader International Study Centre located in Herstmonceaux, East Sussex, United Kingdom (but we are not meeting there ☺).

To locate Queen's University and its various components, you can visit the website http://www.queensu.ca/ or visit the campus map at the following address: http://www.queensu.ca/campusmap/. All of the conference activities will be on the Main Campus site. The Isabel site will be used for the Monday evening activities.

WELCOME AND REGISTRATION

Registration on Friday will be from 2:30 pm to 6:45 pm, in the Biosciences Complex (BioSci) Atrium (east side of Main Campus map—entrance off Arch Street). Dinner (at 5:00 pm) will be held in the BioSci Atrium. The opening session (6:45 pm) and the first opening panel (7:30 pm) will be held in the BioSci theater (room #1101). The reception (9:00 pm) will be held in the BioSci Atrium.

You will also be able to register between 8:00 am and 9:00 am in the BioSci Atrium.

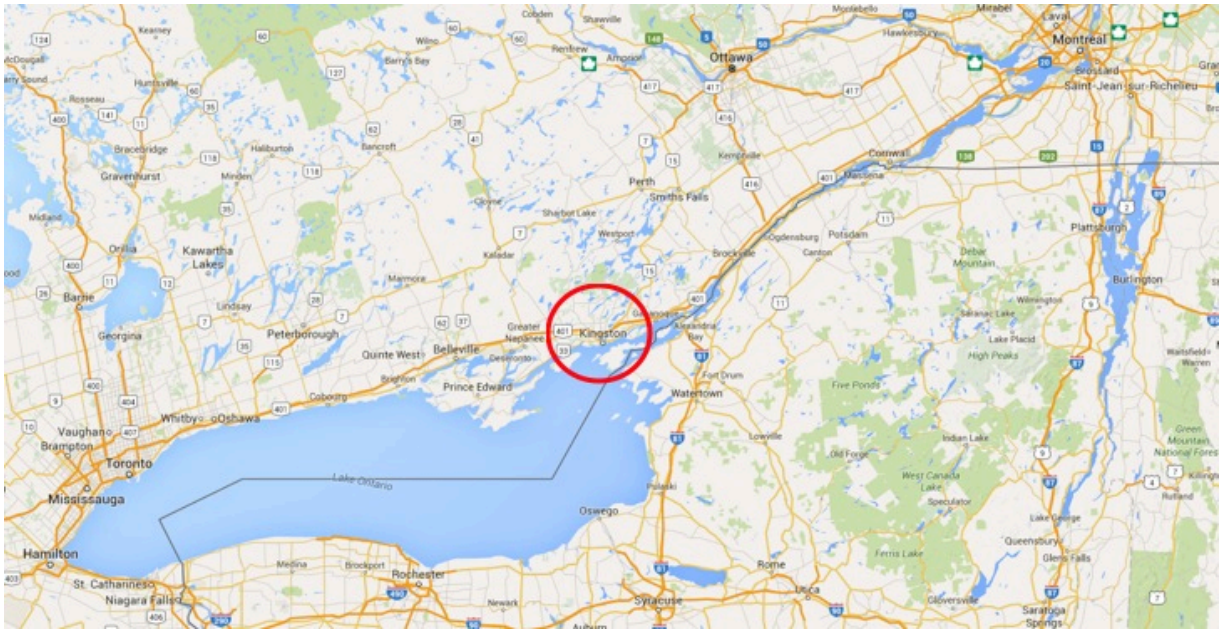
HOW TO GET THERE

Depending on the direction, north, south, east or west, there are several roads leading to the *Queen's University*. The BioSci building is located on campus, on Arch Street. Here are the different routes from the major cities near Kingston.

By Car

- *From Montréal*
  - West on Autoroute 720, then west on Autoroute 20, then west on Ontario's Highway 401
  - About 290 km, or about 3 hours by car
- *From Ottawa*
  - South on Highway 416, and west on Highway 401
  - About 200 km, or about 2 hours by car
- *From Toronto*
  - East on Highway 401
  - About 260 km, or about 2.75 hours by car
- *From Syracuse*
  - North on I-81 to the border of Canada
  - West on Thousand Islands Bridge to Highway 401
  - West on Highway 401
  - About 215 km, or about 2.5 hours by car

Exit:
Follow Highway 401 to Kingston and exit south on Sir John A. Macdonald Blvd. (exit 615). Follow this street south to Union Street, which is at the eighth set of traffic lights. Turn left onto Union and continue for approximately 10 blocks to the Queen's campus. Turn right onto Arch Street to get to the Biosciences Complex (BioSci).

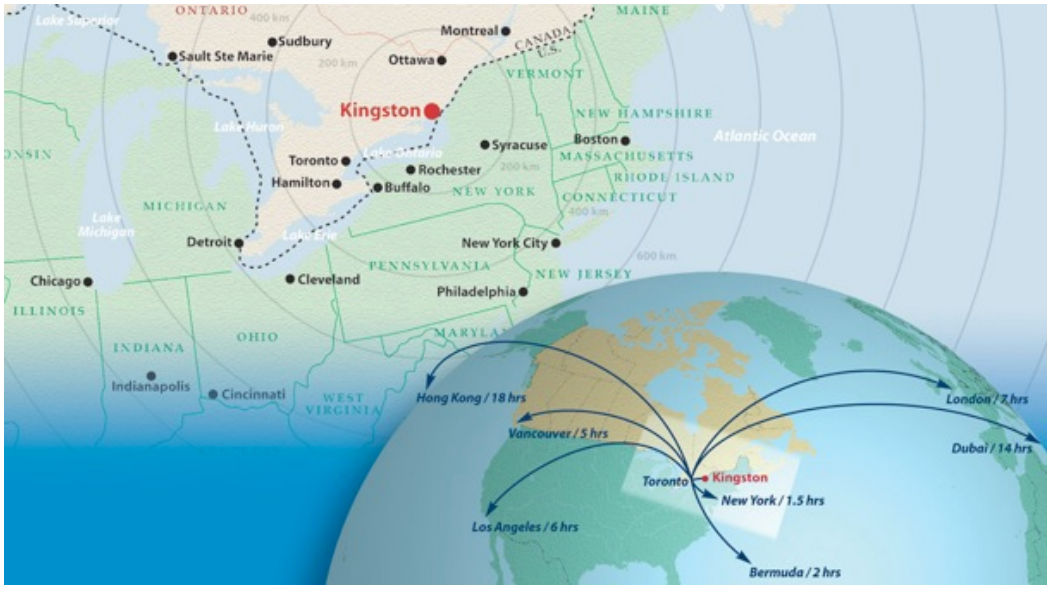


By Train, Bus, or Air (and Taxi)

- Train service to Kingston arrives at the Kingston VIA Rail Station, 1800 John Counter Blvd. (viarail.ca). Plus $16 cab ride.
- Bus service arrives at the Kingston Terminal, 1175 John Counter Blvd. (Megabus greyhound.ca). Plus $14 cab ride.

For those flying into Toronto there are a few options:

- Fly to Kingston (service operated by AirCanada). Plus $18 cab ride.
- Bus from Toronto Airport to Kingston Terminal, or straight to Queen's campus
- Union Pearson Express Train Service (https://www.upexpress.com/) to Union Station (Via). Adult one-way ticket is $12 valid any time.



PARKING

Paid, underground parking (under Nixon Field) is available off Stuart Street at University Avenue. Surface lot parking requires a permit between 0700 hours and 1700 hours, from Monday to Friday – otherwise it is free outside of those hours and on Saturday and Sunday. Check the signs when you park.

Parking while staying in the campus residences will be determined once you arrive at the residence.

ACCOMMODATIONS

We have reserved a block of rooms in the university residences which are located on the main campus of Queen's University. We have two of the newly built residences; Smith House, and Brant House, at the corner of Albert Street and Stuart Street. Available are two-bedroom air-conditioned units with a shared private washroom. Each bedroom has one extra-long double bed, flat screen TV and mini fridge. Towels and linens are included. Nightly rate for a two-bedroom unit is $109.00, plus applicable taxes 13% and dmf 3%. It is not possible to book an individual bedroom. To book your accommodation, please use the following url and event identifying information;

https://devsso.housing.queensu.ca/accommodations-booking/index.php
Event # 27428
Event Name: CMESG 40th Anniversary Conference

If you experience problems with the url, please contact Kristin McKibbin, Coordinator Sales and Marketing, Queen's Event Services, phone 613-533-6000 extension 79432, or by email Kristin.mckibbin@queensu.ca.

HOTELS

There are several hotels available in the Kingston area that are a short drive (or 15-20 min) walk from campus. Here are some options:

Delta Kingston Waterfront Hotel, 1 Johnson Street
(http://www.marriott.com/hotels/travel/ygkdk-delta-kingston-waterfront-hotel/)
Approximately $213 per night.

Holiday Inn Kingston, 2 Princess Street
(https://www.ihg.com/holidayinn/hotels/us/en/kingston/ygkca/hoteldetail)
Approximately $174.25 per night.

Confederation Place Hotel, 237 Ontario Street
(http://confederationplace.com/)
Approximately $115.00 per night.

Residence Inn Kingston Water's Edge, 7 Earl Street
(http://www.marriott.com/hotels/travel/ygkri-residence-inn-kingston-waters-edge/)
Approximately $224.00 per night.

There are a number of B&B's located 5-15 minutes walk from Campus. Explore on a B&B website. Any questions about these feel free to drop a line to Peter <peter.taylor@queensu.ca>.

MEALS

All lunches and dinners will be taken with the group, except for dinner on Saturday (dinner on your own). In this case, you will have the opportunity to explore the unique cuisines offered in Kingston. Breakfast can be included with residence accommodation – arrange that when booking.

EXCURSIONS

One excursion has been arranged.

Kingston 1000 Islands Cruises

Board the Island Queen triple-deck paddle wheeler for a three hour cruise as it winds its way through the small cottage islands of the Admiralty group featuring the remarkable scenery and history of the mouth of the St Lawrence at Lake Ontario. A cash bar operates on two decks, and dinner will be served during the cruise. This is an opportunity to take in fresh air and learn more about the geography and history of the region.

http://www.1000islandscruises.ca/

EMERGENCY

In case of emergency during the conference, you can contact Jamie Pyper at 613-540-0732 or by email at pyperj@queensu.ca. You can also contact Peter Taylor by email at peter.taylor@queensu.ca. The University also has a security service available at 613-533-6733; for emergencies call 613-533-61111. During normal working hours, you can also contact the Queen's Event Services, Kristin McKibbin, Kristin.mckibbin@queensu.ca, 613-533-2223.

FEES

The conference fee ($210 if registration is received by May 2nd and the full payment before May 9th; $240 thereafter) covers the cost of the reception on Friday, lunches on Saturday, Sunday and Monday, dinners on Friday, Sunday and Monday, coffee breaks, the Sunday afternoon excursion and other local costs.

The academic program fee is $95 for all participants except full-time graduate students, for whom the fee is $45. This fee is waived for all *invited* presenters (plenaries, working groups, topic sessions, New PhDs).

Please note: "Ad Hoc" and "Gallery Walk" presenters are required to pay the academic program fee.

ABOUT THE CONFERENCE

CMESG is not a typical academic conference, for it is not organized around presentations and audiences. Instead, it is a conference based on *conferring*.

Its main feature is the **working group.** Each working group meets for three full mornings to interact around a particular topic. Normally, there are two **plenary speakers** and, in contrast with other conferences where questions are often taken at the end of the presentations, time slots are assigned for the audience, broken into small groups, to discuss and prepare questions that are presented to the speakers in separate question periods. However, for this special anniversary meeting there are four plenary sessions and two plenary panels related to the theme of the meeting. These special sessions replace separate question periods (and the small group meetings tied to these sessions), as well as the invited **topic sessions** which normally form one of the two other types of sessions that provide more traditional forms of presentation. The second type, the **new PhD sessions**, will proceed as usual.

Over the course of a meeting (and from meeting to meeting) various discussions and ideas emerge among CMESG members. Our program is designed with time and space for members to come together to work on their emergent ideas. In order to facilitate **Ad Hoc discussions**, there will be a notice board available to request and announce the sessions. Local organizers will assign space for the sessions posted. The nature of the spaces available for ad hoc sessions will reflect the discussion format and the number of sessions proposed. Ad hoc proposers should not expect access to a classroom, computer, projector or power. Hence sessions proposed should be designed with this in mind. There is no reduction in conference fees for presenters in this category. Note— Any person(s) having work prepared in advance to share at the conference should register for the **CMESG Gallery Walk**.

The CMESG Gallery Walk is intended to provide a forum for members to contribute to our meeting and in doing so enhance our awareness of each other's work. We hope this session will increase opportunities for showcasing members' work and building networks among members. We encourage a range of contributions from research posters, to presentations on community initiatives, from mathematics problems, to mathematics art works, anything that can be shared in a gallery format (imagine a poster session or math fair). The session will be broken into two parts allowing every member to participate both as a presenter and as a "walker." One of: a poster board, a piece of the wall, or a table will be provided for each presenter. Presenters will have to supply their own materials and computers (note also, power may not be available). There is no reduction in conference fees for presenters in this category. For more information about this session please contact Olive Chapman at mailto:chapman@ucalgary.ca.

Finally, there is a session that many of us highly value: **meals**! Sit with those you know, sit with those you are getting to know, sit with someone you don't know – the meals are an integral part of the conferring that makes CMESG such a special conference.

FOR THE LEARNING OF MATHEMATICS [FLM] PRE-CONFERENCE

Theme: Challenges and opportunities related to (linguistic) diversity in publishing

All members of CMESG are also members of the FLM publishing association. You are invited to attend the special pre-conference organized by the association, which stats on Thursday, 2 June, at 6:30pm. Visit http://www.cmesg.org/ for details.

PLENARY LECTURES

Lecture I ***Bernard R. Hodgson*** *Université Laval, Québec*	***A human equation: a mathematician's viewpoint on four decades of involvement in mathematical education***

The age of CMESG is almost identical to that of my career as a faculty member: I was indeed a rather young university mathematics professor when I attended the very first CMESG meeting, in 1977. Far from me the idea of using this 40th anniversary as an excuse to abandon myself to surges of nostalgia – not always very fruitful, to say the least. Still it seems appropriate to me to use this talk as a good opportunity for reflecting on different aspects of mathematics teaching and learning, in particular from the teacher education viewpoint.

My situation as a mathematician hired in a mathematics department, but on a position devoted to the mathematical preparation of primary school teachers, is of course of a peculiar type – even today. It would be a blatant euphemism to say that I felt at the outset somewhat at a loss… But the support and the stimulation I could find by being intensively involved in various mathematics and mathematics education communities – in Québec, in Canada (notably with CMESG), as well as at the international level – allowed me to move ahead and eventually really feel at home. This led me to a double conviction: mathematicians do have an important and specific contribution to bring to the mathematical education of teachers, but this contribution can fully flourish only in a context furthering and strengthening the links between mathematicians and mathematics educators involved in the preparation to teaching.

In the background stands a "human equation" involving many parameters: mathematical fields that have turned me on (mathematical logic, history of mathematics); a scientific framework globally focused on mathematical education; an assiduous and sustained involvement in primary and secondary school teachers' education; and exceptionally rich contacts with numerous colleagues, here and elsewhere, who brought me so much and enticed me to go further.

Lecture II ***Carolyn Kieran*** *Université du Québec à Montréal*	***Task Design in Mathematics Education: Frameworks and Exemplars***

Most, if not all of us, in the CMESG/GCEDM community are teachers. We teach for the development of ideas, mathematical practices, and ways of knowing and understanding. The means we use to accomplish these goals include task-based mathematical activity. These tasks, whether we adapt them from existing ones or originate them ourselves, make us all task creators

– task designers in fact. My presentation will delve into the subject of task design in mathematics education – its history, its frameworks, its heuristics.

While the history of task design could be said to go back to the time of Euclid, and perhaps even Pythagoras, it is only within the last 50 years or so that didactical design has become an area of theoretical interest in the mathematics education community. In line with this emergence, I will focus on three aspects: (1) an introduction with a historical flavour, which points to some of the main themes in the theoretical development of the area of task design, (2) a description of frameworks for task design in mathematics education and the principles/heuristics offered by these frames, and (3) examples from current research that illustrate the relation between, on the one hand, frameworks for task design and, on the other hand, the tasks and task-sequences that are developed within a given framework or set of frameworks – a relation that reveals that there are several factors within task design that cannot be accounted for by theoretical frameworks, nor are they under the control of theory, such as, creative insight, the act of arriving at the fine details of a task or task-sequence, and the inevitable mutations brought by instructional practice in the process of engaging students with the designed tasks in the classroom.

Lecture III ***Eric Muller***	***A third pillar of scientific inquiry of complex systems - some implications for mathematics education in Canada***

The European Mathematical Society (EMS) was founded in 1990 and consists of about 60 national mathematical societies in Europe. In 2011 EMS, in a Position Paper on the European Commission's Contributions to European Research[1], stated "*Together with theory and experimentation, a third pillar of scientific inquiry of complex systems has emerged in the form of a combination of modelling, simulation, optimization and visualisation.*" (p.2) I will explore some implications of this third pillar to all levels of mathematics education in Canada. CMESG has a rich 40 year recorded history of Plenary and Working Group reports, and I will refer to a small number of these. For further insight, I will discuss some of our research, with Chantal Buteau, which has focused on the compulsory first and second year *Mathematics Integrating Computers and Applications*(MICA) courses implemented, in 2001, by the Department of Mathematics and Statistics at Brock University. We have argued that these courses may provide an effective way for undergraduates to develop proficiency, through programming, in the third pillar of scientific enquiry of complex systems.

[1] European Mathematical Society, (2011), *Position Paper of the European Mathematical Society on the European Commission's Contributions to European Research – Executive Summary*

Lecture IV ***Peter Taylor*** *Queen's University*	***Structure—an allegory***

The characters in an allegory are imaginary, but they are all the more real for that. They are the selves that stay hidden inside, deep at the core, the selves we love, the selves we fear, the selves we hide from others. Their behaviour is whimsical, juvenile, even ridiculous, but their interactions structure our lives and give it meaning, a meaning we are always striving for even when we have no idea where it could possibly have come from. The wonderful mystery is of course the structure itself; it rules but does not dictate; it is powerful enough to make purpose out of randomness, but it proves nevertheless so hard to capture that the allegory itself is perhaps the only truth that remains.

OPENING PANEL

Ed Barbeau ***Bill Higginson*** ***Bernard Hodgson*** ***Tom Kieren*** ***Peter Taylor*** ***Moderator: Olive Chapman***	***Celebrating the Past***

This 40th anniversary meeting of CMESG/GCEDM is a special landmark as we move into a new decade of the annual gathering of our members. It is, thus, an excellent opportunity to celebrate our history and reflect on and provide inspiration for the future. In this opening plenary panel, we feature founding members of the organization who will help us to 'look back' by sharing key, memorable, informative events that stood out for them during their experience with CMESG/GCEDM and how these have shaped the organization. They will also reflect on the past in relation to their perspective of current state-of-the-art regarding mathematics education.

CLOSING PANEL

Nadine Bednarz ***John Mason*** ***Anna Sierpinska*** ***Walter Whiteley*** ***Moderator: Peter Liljedahl***	***Inspiring the Future***

CMESG has given much to our community and the field of mathematics education over the last 40 years. Looking forward, what can we offer over the next 40 years? This panel, rooted in our individual and collective experiences and history with CMESG aims to offer the members of CMESG/GCEDM, CMESG/GCEDM as an organization, and the field of mathematics education research a set of possible futures for mathematics education in Canada.

WORKING GROUPS

Working Group A *Leaders: Chantal Buteau, George Gadanidis, Miroslav Lovric and Eric Muller*	***Computational Thinking and Mathematics Curriculum***

We plan to study computational thinking (CT) and its integration with mathematics learning and teaching at all levels, from preschool to undergraduate. To frame our discussion, we propose to focus on the following themes:

- Conceptualizing CT in the context of, and in reaction to, the needs of citizens of a 21st century society
- Integration of CT and mathematics curriculum
- Creating good CT problems which address aspects of mathematics curriculum

Throughout the three days, various mathematics activities of different CT types (screen-based; off-screen pseudo-code; and tangibles) concerning different education levels will ground our discussion in order to explore our three themes.

We will start by creating a conceptualization of CT. What is CT? Is it a new way of thinking, what are its defining features? Do we indeed need to engage with CT? Jeanette Wing (2006) thinks so, and suggests that "to reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability." Hinsliff (2015) asks if a child with no programming skills will indeed be left behind.

What CT looks like in education is not well-defined, as it has not really been integrated in mathematics curricula (Grover and Pea, 2013, Lye and Koh 2014). France might provide an example with their recent integration of what they call 'algorithmic thinking' in their school mathematics curriculum (Bulletin Officiel, 2009). Overall, the current insertion of CT in education is more of its own curriculum area, as an end in itself (e.g. in England), rather than integrated with existing subject areas. So, how do we effectively integrate computational thinking into mathematics teaching and learning? We plan to study potential of CT as a vehicle to bring excitement, exploration and experimentation as routine activities (and not "add-ons") into mathematics curriculum and to investigate possibilities of making CT a backbone around which we could build a cohesive mathematics curriculum, unconstrained by the traditional "boxing" of math sub-disciplines and topics.

By creating engaging problems and tasks we plan to envision what the teaching of mathematics through CT would look like. Among other goals, we need to find ways to transfer "fun" of

constructing and "playing" with computer code into math; i.e., to investigate computational thinking as a tool to stimulate students' interest and increase their motivation to engage with mathematics.

References:

Bulletin Officiel (2009). Number 30, July 23. Mathématiques Classe de seconde.http://media.education.gouv.fr/file/30/52/3/programme_mathematiques_seconde_65523.pdf. [accessed January 2016].

Grover, S. and Pea, R. (2013). Computational thinking in K-12: A review of the state of the field. *Educational Researcher, 42*(1), 38-43.

Hinsliff, G. (2015). Should Kids Learn to Code? The Guardian, 3 December 2015. http://www.theguardian.com/news/2015/dec/03/should-kids-learn-code

Lye, S.Y. and Koh, J.H.L (2014). Review on teaching and learning of computational thinking through programming: What is next for K-12? *Computers in Human Behavior 41*, 51-61.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35.

Working Group B *Leaders: Frédéric Gourdeau and Kathy Nolan*	***Mathematics in teacher education: What, how... and why***

The mathematical education of elementary and secondary prospective mathematics teachers involves several dimensions of knowing and doing. Many researchers have paid attention to, and developed models for, describing its complexity in ways which help us understand these dimensions better. Among these, Ball's Mathematical Knowledge for Teaching (MKT) is probably the most well-known in Canada. MKT is often contrasted to Advanced Mathematical Knowledge (AMK), with many studies concluding that AMK courses are not useful and, in some cases, are even detrimental to teachers. Even if the precise definition of AMK courses varies with authors and educational systems, it is often used to describe traditional university service courses which focus on algorithms, techniques and methods, often at the expense of an emphasis on understanding. Research also points to the reality that teacher education courses can talk *about* how best to teach and learn mathematics without providing ample opportunities for prospective teachers to learn mathematics and to learn it *through* these approaches.

In this working group, key questions relating to the education and preparation of K-12 mathematics teachers will be asked—these questions include what mathematics do (we believe) teachers need to know, how do they need to know it, and, last but not least, why do we think this way. Participants attending this working group will have opportunities to deepen and enrich ways of looking at the mathematical preparation of teachers and to explore different frameworks or different conceptualisation for the mathematical preparation of teachers. We will consider approaches which can be claimed to promote a fruitful engagement with mathematics in teacher education. One such idea is deep subject knowledge, which is widely expressed as an important dimension of teachers' mathematical knowledge for teaching (Adler et al., 2014). Another idea, which touches on Mathematical Habits of Mind, is that of pre-service (or in-service) teachers being engaged in the doing of mathematics, an idea which turned out to be pre-eminent in a 2012 colloquium which brought together mathematics educators and mathematicians engaged in pre-service teacher education (Proulx et al., 2012).

As participants in the working group, we will also have opportunities to share perspectives arising from our own respective programs' goals of mathematics and mathematics education courses; our current practices of how we engage students in doing mathematics, in understanding different ways of knowing mathematics and in feeling competent and confident in doing mathematics. We will consider different methods advocated in mathematics education courses, such as teaching and learning through inquiry approaches and Big Ideas in Mathematics, thus providing a true K-12 focus in the working group. Participants will experience activities presented by the facilitators, but also by participants in the working group, with the activities serving as the basis for discussion about what/how (and why) they can help develop in new mathematics teachers.

References:

Adler, J., Hossain, S., Stevenson, M., Clarke, J., Archer, R., & Grantham, B. (2014). Mathematics for teaching and deep subject knowledge: Voices of Mathematics Enhancement Course students in England. *Journal of Mathematics Teacher Education, 17*, 129–148. DOI 10.1007/s10857-013-9259-y

Hart, L., & Swars, S. (2009). The lived experiences of elementary prospective teachers in mathematics content coursework. *Teacher Development, 13*(2), 159-172, DOI: 10.1080/13664530903043988.

Proulx, J., Corriveau, C. et Squalli, H. (2012). *Formation mathématique des enseignants de mathématiques: Pratiques, orientations et recherches.* Québec: Presses de l'Université du Québec.

Working Group C *Leaders: Elena Polotskaia, David Reid, and Richard Hoshino*	***Problem-Solving: Definition, Role, and Pedagogy***

Before entering politics, Justin Trudeau was a high school mathematics teacher in BC. In his memoir, he presents the following two "problems" as examples he used in his teaching to build critical thinking and problem-solving in his students.

(1) A customer enters the 7-11 convenience store, selects four items, and watches the cashier multiply the four prices on his calculator, to obtain the product $7.11. The customer notices the mistake and asks the cashier to add the prices instead; he does so, and is surprised to see that the total sum is also $7.11. How much did each item cost?

(2) A father and daughter go fishing. After they return home, the father asks his daughter to give him one of her fish, so that they could have the same number. The daughter responds that if her father gave her one of his fish, then she would have twice as many as him. How many fish did each person catch?

But are these truly problems? The first, though cute, is contrived and can only be solved by trial-and-error, while the second can be easily formulated as a routine system of two equations and two unknowns, and be solved without much insight.

In this working group, we will discuss and identify features of great problems, and compile a list of problems that inspire meaningful problem-solving experiences for our students. (Speaking of which, the above father/daughter problem has a beautiful non-algebraic solution: can you find it?)

Over the three days, we will have three main foci:

- Discuss and come to a definition of what makes a good problem, and come to a definition of what we mean by "problem-solving".
- Discuss the role of problem-solving in K-12 schools, especially as problem-solving is now more a method of teaching than a specific topic to teach in the curriculum.
- Discuss how problem-solving should be addressed with future educators: in our methods courses, should we explicitly teach problem-solving heuristics and strategies, or perhaps teach content that incorporates problem-solving?

  We will start the working group by having each participant present their favourite problem, and invite them to explain the features of the problem that are conducive to problem-solving.

References:

Schoenfeld, Alan H. (1987) Confessions of an accidental theorist *for the learning of mathematics*, Vol. 7 Num. 1, 30-38

Davydov, V. V. (1982) Psychological characteristics of the formation of mathematical operations in children. In T. P. Carpenter, J. M. Moser, & T. A. Romberg, eds. Addition and subtraction: cognitive perspective. Hillsdale, New Jersey: Lawrence Erlbaum Associates, pp. 225-238.

Working Group D *Leaders: David Guillemette and Cynthia Nicol*	***Mathematics Education and Social Justice: learning to meet the Others in the classroom***

> A properly ethical relationship to the Other, and the acceptance of a genuine personal responsibility, implies the presence of a loving consciousness and the absence of a reifying and interested look. The abstract contemplation of the world incessantly risks of supplanting our active and embodied participation in a common horizon of values and meaning. Pullout off the interactive context that links the Self, the Other and the World, the subject succumbs to solipsism. He then loses his footing, becomes empty, arrogant, degenerates and dies (Bakhtin, 1978/1997, p. 40, free translation).
>
> In this context where reigns the Object and where sovereignty of technical powers is exalting, freedom consists in maintaining ourselves against the Other, despite any relationship with the Other, ensure the autarky of the Self. (Levinas, 1961/2010, p. 36-37, free translation)

All human interaction involves the experience of Otherness. Mathematical activity is not an exception. Whether through history, social practices, language, aesthetic experiences or cultural practices, the experience of Otherness in mathematics comes ineluctably, consubstantial of teaching-learning. In this light, different kinds of reasoning, languages and orientations appear, as many voices claiming their legitimacy and space of action in the mathematical world. Necessarily, this perspective carries fundamentally critical aspects by bringing into focus fragile, marginal or in-minority ways of being-in-mathematics, often suggesting social and political demands. This perspective also suggests there is no ideologically neutral knowledge and that all acts of knowing are embedded in an ethical problem for which we need to develop our

sensitivity. Such a focus on the experience of Otherness stands in contrast to a capitalist ideology and its shadow, universalism.

But what are these marginal voices? What actions can be taken to give them more space to be heard? What implications does this have for the mathematics classroom? What are the current prospects for research on/in this thematic? Above all, what conceptual or theoretical frameworks can help us think about mathematics education in these terms?

The sociality of the learning process means for us the formation and transformation of consciousness, which is precisely (con)sciousness, that is to say "common knowledge" or "to-know-with-others." In this context, the mathematics classroom doesn't assign itself the role of promoting an individualistic idea of autonomy, but rather one as social engagement (*cf.* Arendt, 1961), where the fundamental openness to the Other and the respect of the Otherness appear central and decisive to us.

This is the deep sense in which we will try together to question the idea of Social Justice and theme of Otherness in the context of mathematics education. We will try to do so by examining various theoretical and conceptual frameworks that address mathematical education in these terms and examples of research issues and problems experienced in mathematics classrooms. The numerous and bright works from the recent Mathematics Education and Society (MES) conferences (Mukhopadhyay and Greer, 2015) will provide some material for our exploration

References:

Arendt, H. (1961). *Between past and future: six exercises in political thought*. Cleveland: World Pub Co.

Bakhtin, M. (1997). *Esthétique et théorie du roman*. Paris : Gallimard. (Originally published in 1978)

Levinas, E. (2010). *Totalité et infini : essai sur l'extériorité*. Paris : Librairie Générale Française. (Œuvre originale publiée en 1961)

Mukhopadhyay, S. & Greer, B. (Eds.) (2015). *Proceedings of the Eighth International Mathematics Education and Society Conference (MES 8)*. Portland, Oregon: Portland State University.

Working Group E *Leaders: Nathalie Sinclair and Patricia Marchand*	***Role of spatial reasoning in mathematics***

The working group will explore the role of spatial reasoning in mathematics teaching and learning. There will be a particular emphasis on elementary school mathematics, but we will also examine ways in which spatial reasoning can be extended both outside of the traditional geometry curriculum and into middle and high school mathematics.

We will draw on recent research in mathematics education and cognitive science to inform our discussion of what spatial reasoning can look like and to understand how and why it might be significant for mathematical learning. We will draw on philosophical and historical considerations to help us appreciate why spatial reasoning has received, in the past, much less attention both in research and practice. We will mainly explore some activities that have been designed to emphasise spatial reasoning and discuss how these might be further refined and extended. We will be particularly interested in activities that foster dynamic forms of spatial reasoning, given the importance these seem to have in mathematical activity.

Working Group F *Leaders: Elaine Simmt and Annie Savard*	***The Public Discourse About Mathematics and Mathematics Education***

Mathematics education is a cornerstone of public schooling. A look across time suggests arithmetic and geometry has been part of mathematics education since antiquity, but it is only in the last half century where mathematics education, in broader and more rigorous forms has been intended for *all children and youth* (in Canada, and now even in the least affluent of nations who accept primary education as a basic human right).

For decades mathematics educational researchers have been studying, and proposing suitable curriculum and teaching methods that are intended to provide learners with meaningful experiences which will lead to a highly numerate and mathematical persons. Curriculum developers and policy makers use that research to create mathematics curriculum for all learners. With the broader goals of mathematics for all (Goos, Geiger et al., 2014), teaching strategies learners are encountering that are unfamiliar to parents, and the pervasiveness of social and

traditional media, mathematics education has become heightened in the public discourse and highly politicized.

At the 2014 CMESG annual meeting in Edmonton, a panel responded to the media attention to the 2012 PISA results. The print and television media were in attendance and continued the conversation with an article about the "Math Wars". As an organization we have not responded; however, the conversation has been continuing without us. In this working group we will:

- explore the messaging that is permeating the media;
- ask ourselves about the underpinning beliefs and assumptions about mathematics and mathematics education, their contents, practices and goals that: a) we hold and b) that are found in the social and traditional media and other forms of public discourses about mathematics education;
- investigate possible areas of convergence;
- propose counter narratives to those that are permeating the media;
- ask ourselves about how we can play a greater role in the media mediated discussion of mathematics education;
- prepare speaking points for our interactions with the television and radio media, an editorial piece for the print media and video;
- prepare a strategy for enhancing Canadian mathematics educators voice in the public discourse (e.g. blog on CMESG website)

We hope that the work of this WG will produce something that provides a basis for addressing the media!

References:

Goos, M., Geiger, V. & Dole, S. (2014). Transforming professional practice in numeracy teaching. In Yeping Li, Edward A. Silver and Shiqi Li (Ed.), *Transforming mathematics instruction: multiple approaches and practices* (pp. 81-102) New York, United States: Springer.

Andrea Sands (2014). Math Score don't add up. *Edmonton Journal*, June 4, 2014, p. A5.

Mathematics Panel Discussion (2014). What have we not been hearing about the PISA? In Susan Oesterle and Darien Allan (Ed.), *Proceedings of the Annual Meeting of the Canadian Mathematics Education Study Group*. Edmonton, Alberta, Canada.

NEW PHD SESSIONS

Sean Chorney	***From Agency to Narrative: Tools in Mathematical Learning***

My dissertation explores ideas from new materialism as a theoretical lens for understanding the role of tools within mathematical practice. This approach offers the opportunity to articulate a non-dualist approach to mathematics—with a focus on the entanglement of tools, humans and concepts. The focus of mathematical learning in this dissertation is neither on the student nor on the tool, but on the coupled entity "student–tool".

In my exploration of understanding the role of tools I inquire into the notion of agency (especially in the work of Pickering and Latour), and end with the inclusive materialism of de Freitas and Sinclair.

I explore the potential and productive overlaps between different post-humanist, materialist theories and indicate how the new theoretical ideas that this dissertation engages with might pose and address certain questions in mathematics education research.

Doris Jeannotte	***A Conceptual Model Of Mathematical Reasoning For School Mathematics***

The development of students' mathematical reasoning (MR) is a goal of several curricula and an essential element of the culture of the mathematics education research community. But what mathematical reasoning consists of is not always clear and it is generally assumed that everyone has a sense of what it is. Wanting to clarify the elements of MR, I aimed to qualify it from a theoretical perspective, with an elaboration that would serve as a tool for reflection and thereby contribute to the further evolution of the cultures of the teaching and research communities in mathematics education. To achieve such an elaboration, a literature search based on *anasynthesis* (Legendre, 2005) was undertaken. From the analysis of the mathematics education research literature on MR and taking a commognitive perspective (Sfard, 2008), the synthesis that was carried out led to conceptualizing a model of mathematical reasoning. This model is constituted of two main components: a structural component and a process component, both of which are needed to capture the central characteristics of MR.

Vincent Martin	***A study of the teaching of probability to students judged with or without learning difficulties in mathematics in regular elementary classes in Québec***

In Quebec, a majority of elementary students with difficulties are taught in regular classes, but few studies have specifically characterized mathematics education provided to these students in this context. By using the concept of didactical intervention (Vannier, 2006; Vannier & Eichner, 2011) and a conceptual analysis of probabilities, the teaching practices of two third cycle teachers were studied. These teachers worked with the same didactical resource in order to teach probability to elementary students of regular classes they judged with or without mathematics learning difficulties. The results obtained show that the teachers had difficulties with the frequentist probabilistic perspective and with the institutionalization of mathematical knowledge included in this task. They point out that the didactical conditions offered to the students judged with mathematics difficulties were of the same nature as those offered to the other students, but were less frequent and were given at particular moments.

Petra Menz	***Unfolding of Diagramming and Gesturing between Mathematics Graduate Student and Supervisor during Research Meetings***

Rather than treating the mathematical diagram as a visual representation of already existing mathematical objects and relations, Châtelet regards the diagram as a material site of engaging with and mobilizing the mathematics through his study of historical, mathematical manuscripts. His approach is employed in this study to create a window into the realm of mathematical thinking and invention by examining how a graduate student (as the less-expert mathematician) and his supervisor and two research colleagues (as the expert mathematicians) interact with diagrams. An embodied lens, based on the work of de Freitas, Roth, Rotman, Sinclair and Streeck, exposes the similarities and differences in the way that each class of mathematician gestures and diagrams. In this manner, this study achieves two purposes, namely to confirm and advance Gilles Châtelet's theory to the context of live mathematical activity and to elucidate the enculturation process of a graduate student into mathematical research.

Valériane Passaro	***Analysis of covariational reasoning promoting the passage from the function to the derivative and of situations that lead 15 to 18 years old students to deploy that reasoning***

To better understand the transitional challenges between high-school and post-secondary education, we propose a study of the passage from the notion of function to the notion of derivative. Based on numerous studies on the difficulties related to this passage and, more specifically, on the work of Carlson and colleague's (Carlson, 2002; Carlson et al., 2002, 2001; Oehrtman et al., 2008) on covariational reasoning, we present an analysis of the dynamics of the development of covariational reasoning. By submitting four different problem-situations to small groups of students ending secondary school and beginning college (15-18 years old), we were able to examine that development. Bringing out the reasoning units and analysing their connections allowed us particularly to refine the grid proposed by Carlson and to reveal the influence of certain characteristics of the situations on the non-linear interactions between those units.

Derek Postnikoff	***Conceptual metaphor and coherent integration in the philosophy of mathematics***

Traditionally, mathematics and metaphor have been thought of as disparate: the former rigorous, objective, universal, eternal, and fundamental; the latter imprecise, derivative, nearly — if not patently — false, and therefore of merely aesthetic value, at best. A growing amount of contemporary scholarship argues that both of these characterizations are flawed. My interdisciplinary doctoral research shows that there are important connexions between mathematics and metaphor that benefit our understanding of both. In this paper, I argue that an understanding of metaphor as conceptual can help explain how mathematics is grounded, and simultaneously provides a mechanism for reconciling and integrating the strengths of traditional theories of mathematics usually understood as mutually incompatible.

Vanessa Rayner	***Developing Preservice Teachers' Professional Noticing of Students' Learning***

A two-group pretest-posttest experimental design was used to examine the effects of an intervention on preservice teachers' (N = 29) ability to specify learning goals of a lesson (Skill 1), collect evidence of student learning (Skill 2), generate hypotheses (Skill 3), and propose alternative teaching strategies (Skill 4; Hiebert et al., 2007). The Learning Goals group received instruction on all four skills while the Students Learning group received instruction on Skills 2, 3, and 4. A subsample of preservice teachers from both conditions (n = 8) were individually interviewed to examine the nature of Skill 1. The results revealed significant improvement on Skills 2, 3, and 4, and no difference on mean Skill 1 performance on the post-assessment. The interview data revealed qualitative differences in the nature of Skill 1. Overall, the results indicated that Skills 2, 3, and 4 do not develop naturally and are learned.