CANADIAN MATHEMATICS EDUCATION STUDY GROUP

43RD ANNUAL MEETING

MAY 31ST TO JUNE 4TH, 2019

ANNOUNCEMENT AND PROGRAM

We welcome you to St. Francis Xavier University for the 43rd Annual Meeting of CMESG/GCEDM, which begins at 6:30 pm on Friday May 31st and ends at 12:30 pm on Tuesday June 4th.

We are delighted to welcome you to Antigonish, Nova Scotia. Derived from the Mi'kmaw word Nalikitquniejk, meaning the place of the torn limbs or where the bears break branches, Antigonish is located in Mi'kma'ki, the traditional, ancestral, and unceded territory of the Mi'kmaq People. To learn more about our small town check out this website: (https://www.townofantigonish.ca/about-antigonish.html).

Founded in 1853, St. Francis Xavier University (https://www.stfx.ca/) has a long and proud tradition as one of Canada's oldest universities. For almost 165 years, we have cultivated our strong and resilient spirit, dedication to intellectual rigour, and commitment to engaging students who aspire to be community-minded citizens of the world. Our motto Quaecumque Sunt Vera, or "Whatsoever Things are True" perfectly captures our values of integrity, dignity, truth, and respect for all. One of Canada's oldest and most prestigious universities, St. Francis Xavier is consistently ranked the best undergraduate university in Canada.

The first university in Canada to have a formal Service Learning program, StFX values community development, social justice and global awareness. We are home to the internationally-recognized Coady International Institute, and students find leadership development opportunities here that they can apply in all aspects of their lives. Students who are committed to and embody these values thrive at StFX.

Our close-knit residence environment is at the heart of the StFX experience. Students live and learn together in a thriving academic environment. They have a wide variety of fascinating programs to choose from in the faculties of Arts, Science and Education, and within the Gerald Schwartz School of Business.

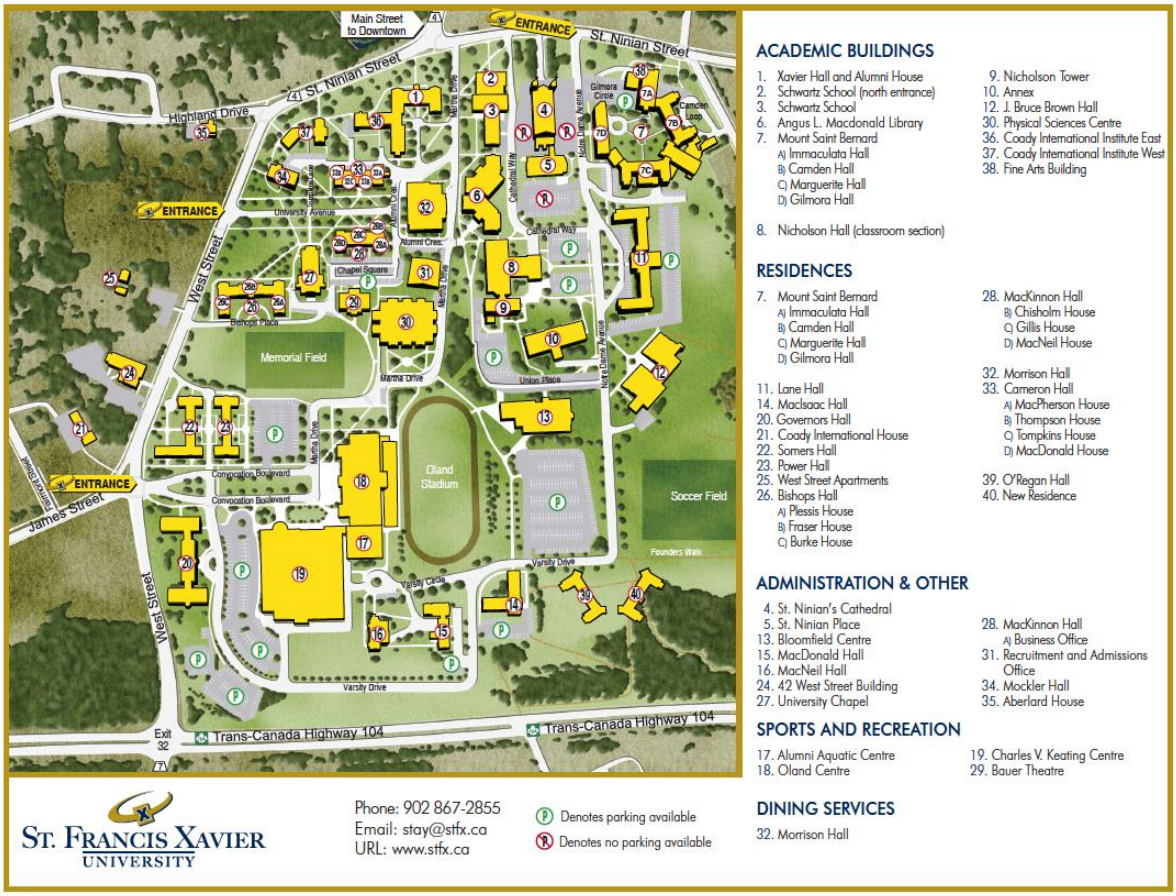
Our 45,000 worldwide alumni are a strong and engaged community, and provide a valuable network for graduating students.

WELCOME AND REGISTRATION

Registration on Friday will be from 2:30 pm to 6:45 pm, on the first floor of the Schwartz School of Business (#2&3 on map), outside the Schwartz Auditorium where the opening session and 1st plenary will take place. The post-plenary reception will be held in the McKenna Centre on the 4th floor of Schwartz. A Barbecue (at 5:00 pm) will be held in Xavier gardens (weather permitting) across from the Schwartz Building and in front of Xavier Hall (#1 on map).

We will be providing you with a conference agenda, that will include all of the key information that you will need to know – e.g. official schedule, phone numbers, Wi-Fi password (please note Eduroam is available on campus). However, we will not be providing any mugs or water bottles, so we ask you to bring your own mug and/or water bottle to use during the conference.

CMESG events will primarily take place in Xavier hall and Schwartz. Breakfast (included in your on campus room accommodations) and lunch will take place in Morrison Hall (#32 on map) our main campus dining Hall.



HOW TO GET THERE

StFX is approximately a two-hour drive from Halifax's Stanfield International Airport (YHZ). It is about 2.5 hours from the Greater Moncton Roméo LeBlanc International Airport (YQM) which is also an option for getting here. There are various forms of transportation from the Halifax airport to the university including buses and shuttles. You might also choose to rent a car.

Taking The Bus

Buses run from the Halifax Airport to Antigonish daily. The Bus will bring you right to campus. There are 2 or 3 runs a day from the airport depending on the day. You can find bus schedules and rates on the Maritime Bus website. https://maritimebus.com/

A number of shuttle companies run daily from Halifax to Sydney (Cape Breton) with stops in Antigonish. Typically, these shuttles stop at the Tim Horton's on James St which is directly across from Governor's Hall where you will check in for your accommodations. The Halifax International Airport has a number of shuttles listed here: https://www.halifaxstanfield.ca//wp-content/uploads/2015/07/Shuttle-Schedule.pdf

Coming by Car

Some participants may wish to rent a car and take a quick (under 2 hours) drive to Antigonish. The Halifax International Airport has a number of options available for renting a car (https://halifaxstanfield.ca/transportation/car-rentals/). If you plan to rent a car and would like to carpool, we have created a Google document to help you connect and share space.

Link:https://docs.google.com/spreadsheets/d/1H5ms4NVDuU2WkFUzhYq7wgAG1HI6oPyscAcv0v3tAK8/edit?usp=sharing

Please note at the bottom of this document you will find tabs for those who may be seeking a roommate for the traditional style dorms.

Driving from Halifax Airport (https://goo.gl/maps/3ue4e5yEG1o)

Get on NS-102

- Head east on Bell Blvd toward Barnes Dr
- Keep right to stay on Bell Blvd
- Use the right lane to take the Nova Scotia 102 N ramp to Truro

Follow NS-102 and Trans-Canada Hwy/NS-104 E to Nova Scotia Trunk 7 in Antigonish, Subd. A. Take the 32 exit from Trans-Canada Hwy/NS-104 E

- Merge onto NS-102
- After Truro, Take exit 15E for Trans-Canada Highway/NS-104 E toward New Glasgow/Cape Breton/PEI Ferry Caribou
- Merge onto Trans-Canada Hwy/NS-104 E
- In 114 km, Take Exit 32

Follow Nova Scotia Trunk 7 to Convocation Blvd in Antigonish

- At the roundabout, take the 3rd exit onto Nova Scotia Trunk 7
- At the next roundabout, take the 1st exit onto Nova Scotia Trunk 7 E
- At the second set of lights, turn right onto Convocation Blvd

Driving from Nova Scotia / New Brunswick Border

Head southeast on Trans-Canada Hwy/NS-104 E for approximately 220km. (Note: This is a toll road)

- Take Exit 32 at Antigonish

Follow Nova Scotia Trunk 7 to Convocation Blvd in Antigonish

- At the roundabout, take the 3rd exit onto Nova Scotia Trunk 7
- At the next roundabout, take the 1st exit onto Nova Scotia Trunk 7 E
- At the second set of lights, turn right onto Convocation Blvd

Driving From Cape Breton

- Follow highway to Port Hawkesbury and the Canso Causeway
- Follow the causeway onto Highway 104 towards Antigonish - approximate half hour drive from the causeway
- Turn off at Exit 32 to Antigonish

Follow Nova Scotia Trunk 7 to Convocation Blvd in Antigonish

- At the roundabout, take the 3rd exit onto Nova Scotia Trunk 7
- At the next roundabout, take the 1st exit onto Nova Scotia Trunk 7 E
- At the second set of lights, turn right onto Convocation Blvd

PARKING

Parking is free. Please let a member of residence staff know you will be parking on campus when you check in.

ACCOMMODATIONS

We have blocked rooms in both Governors Hall (#20 on map) and MacIsaac Hall (#14 on map). You can book your accommodations here: https://hotel.stfx.ca/cmesg.bnb

Affectionately known as one of the hotels, standard rooms in Governors Hall include 1 double bed, a working desk and complimentary high-speed wireless internet. Amenities include a microwave and a fridge, private washroom with shower/bathtub (rooms with walk-in shower available upon request), shared gourmet kitchens & lounge area available on each floor, laundry facilities on site. Also, guests can enjoy access to our pool and to our large fitness centre. The cost is $105 per night, plus tax and includes 1 breakfast per day. Additional breakfasts tickets may be purchased on site @ $10.00 plus HST. Sleeps 2.

MacIsaac Hall is a traditional style residence. Double rooms are appointed with two twin beds, two desks and two chairs. There are shared private washrooms located in the hallways with approximately 1 washroom for every 7.5 guests. You will find a lounge on each floor. There is a laundry facility on site. Your room rate of $70 includes one breakfast in Morrison Hall Dining Room for each night booked for the conference. Additional breakfasts tickets may be purchased on site @ $10.00 plus HST. Please let us know if anyone will be staying with you when you book.

For those of you wishing to stay at a hotel, there are a few options within walking distance of the university.

Claymore Inn and Suites
137 Church Street
Antigonish, Nova Scotia
B2G 2E2
1-902-863-1050
1-888-863-1050
http://claymoreinn.com/

Maritime Inn Antigonish
158 Main Street,
Antigonish, Nova Scotia
B2G 2B7
1-866-430-4982
http://www.maritimeinns.com/en/home/maritime-inn-antigonish/default.aspx

MEALS

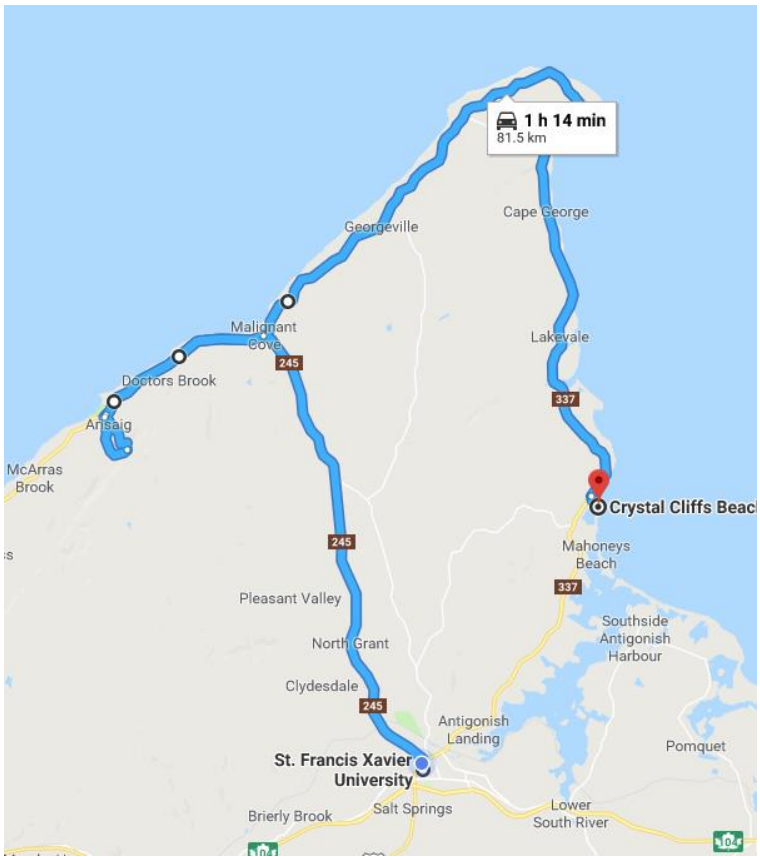
All lunches and dinners will be taken with the group, except for dinner on Saturday (which will be dinner on your own). There are plenty of local restaurants all within walking distance of the university for you to try. We will be providing lists of places to eat and drink with your registration package when you arrive.

Breakfast will be offered each day in Morrison Hall for those staying in residence, and the price is included in your accommodation fees. If you are staying off campus and would like to have breakfast on campus, you can pay at the door. There are also a number of places in town to get a good breakfast.

On Sunday evening we will be having dinner at Crystal Cliffs, a beach owned by the University following our excursion. Our Monday evening banquet will be at the Antigonish Legion in partnership with the Canadian Association for Community Living (CACL) who share space and programs in an innovative social enterprise. This is a very short walk from the university.

EXCURSIONS

On Sunday, our primary excursion will be a tour of the "mini trail" (see map below) where we will see beautiful scenery as we visit beaches, lighthouses, fishing villages, and the world-renowned Steinhart's Distillery (https://www.steinhartdistillery.com/) who were recently recognized for having the world's best classic gin - they make some great vodka too! We will end our trip at Crystal Cliffs, where you can take a walk along the beach or wander around the grounds before joining us for steak and lobster in the "rustic chic" barn.



For those who might like to do something a little different, we can organize transportation to the Keppoch (https://www.thekeppoch.ca/), a year round outdoor recreation space, to do some hiking and biking. If you want to visit the Keppoch, please indicate this on the registration form when prompted so that we can arrange transportation and let them know you're coming. Others may just want to explore the town, follow a walking trail and enjoy an afternoon tea of a local coffee shop. For those not on the primary excursion, a bus will leave campus to bring you to Crystal Cliffs for dinner. The time and details will be announced at the conference.

EMERGENCY

In case of emergency during the conference, you can contact StFX Security at 902-867-4444.

FEES

The conference fee ($ 210 if registration is received by April 21st 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 $ 110 for all participants except full-time graduate students, for whom the fee is $ 60. 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.

FRIENDS OF FOR THE LEARNING OF MATHEMATICS [FLM]

All members of CMESG are also members of the FLM publishing association.

You are invited to meet the FLM journal editor, managing editor and board members at the annual Friends of FLM. This is an informal welcome event organized by the association and an opportunity to learn more about FLM. What makes FLM different? It's the people and more! Everyone invited. Drop by. Refreshments provided.

Friday May 31 15h30 – 16h20. Xavier Hall 228A&B

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 will meet for three full mornings to interact around a particular topic. There are two **plenary speaker sessions** which will each address the whole conference. In contrast with other conferences where questions are often taken at the end of the presentation, a time slot is assigned for the audience, broken into small groups to discuss and prepare questions that will be presented to the speakers in a question period. Two other types of sessions provide more traditional forms of presentation: invited **topic sessions** and the **new PhD sessions**.

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 Peter Liljedahl: liljedahl@sfu.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.

PLENARY LECTURES

Lecture I ***Jean-Marie De Koninck*** Université de Laval	***Discovering mathematics together with the students***

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Lecture II ***Rochelle Gutierrez*** University of Illinois	***Mathematics as Dispossession: Reclaiming Mental Sovereignty by Living Mathematx***

Throughout history, Indigenous people have experienced a process of dispossession (e.g., land, language, culture) through governmental policies that reflect a perspective of "Kill the Indian." In this presentation, I analyze some of the specific ways that Eurocentric mathematics plays a powerful role in continuing the process of dispossession by valuing and sanctioning only certain kinds of ontologies and epistemologies that side with colonialism. Beginning with three concepts upon which I was raised (In Lak'ech, Nepantla, and reciprocity), I argue for a form that respects and supports Indigenous worldviews among others. This form of mathematics seeks, acknowledges, and creates patterns and relationships that solve problems and offer joy—something I refer to as mathematx. Mathematx addresses the need for Indigenous people to continue to remake ourselves while interacting with non-Indigenous people because, among other things, it decenters humans, seeks to intervene in the world, addresses ethics, and is reflective of a way of "being" that respects mental sovereignty. In unpacking the concepts of dispossession and mathematx, I turn what has been referred to as the "Indian mathematics problem" on its head and suggest this reframing offers lessons for non-Indigenous people as well.

WORKING GROUPS

Working Group A *Leaders: Jeff Hooper, Laura Broley*	***Problem-Based Learning in Post-Secondary Mathematics.***

The phrase *Problem-Based Learning* (PBL) has been used to describe a pedagogy, which, in its purest form,

> *begins with a problem to be solved, and the problem is posed is such a way that students need to gain new knowledge before they can solve the problem. Rather than seeking a single correct answer, students interpret the problem, gather needed information, identify possible solutions, evaluate options, and present conclusions.* (Roh, 2003, p. 1)

This approach is not new to post-secondary education. In fact, 2019 marks the 50th anniversary (!) of the first ever PBL program (implemented in Canada, at McMaster University's School of Medicine; Servant-Miklos, 2018). Despite its success, similar programs have not emerged widely, and especially not in Post-Secondary Mathematics. The goal of our working group is to explore the nature, purpose, and potential of PBL in this particular context.

We expect to guide our exploration along three lines of questioning:

1. Conceptualization: e.g., What are the key components of PBL? What is gained or lost in taking such an approach? What constitutes a "good problem" for PBL in Post-Secondary Mathematics?
2. Implementation: e.g., Does it make sense to talk about a PBL program in mathematics? How else could we imagine (variations or components of) PBL being integrated in Post-Secondary Mathematics? What challenges might be faced in attempting this integration?
3. Research: e.g., Which questions should be addressed by mathematics education research on PBL? Which theoretical frameworks and methodologies could be pertinent for such research?

Since PBL involves elements of mathematical inquiry, the existing work on Inquiry-Based Learning and Education may provide useful resources for us (see, e.g., Spronken-Smith, 2008; Artigue & Blomhøj, 2013). Fellow participants are invited to bring their own burning questions and (hopefully!) mathematical problems. As a group, we will work together to try to find some answers!

References

Artigue, M., & Blomhøj, M. (2013). Conceptualizing inquiry-based education in mathematics. *ZDM Mathematics Education, 45,* 797–810.

Roh, K.H. (2003). Problem-based learning in mathematics. *ERIC Digest*. Retrieved from https://eric.ed.gov/?id=ED482725

Servant-Miklos, V.F.C. (2018). Fifty years on: A retrospective on the world's first problem-based learning programme at McMaster University Medical School. *Health Professions Education*. Retrieved from https://doi.org/10.1016/j.hpe.2018.04.002

Spronken-Smith, R. (2008). Experiencing the process of knowledge creation: The nature and use of inquiry-based learning in higher education. Retrieved from https://ako.ac.nz/assets/Knowledge-centre/inquiry-based-learning/e2e5eee06f/SUMMARY-REPORT-Inquiry-based-Learning.pdf

Working Group B *Leaders: Vincent Martin, Jennifer Holm*	***Teaching primary school mathematics. What mathematics? What avenues for teacher training?***

When entering an initial teacher education program, prospective teachers generally express a negative sense of mathematics (Holm, 2018). Moreover, a majority of them present significant mathematical difficulties (Kajander, 2010; Morin, Theis, & Rosa-Francoeur, 2012). Their own academic experience of mathematics, often considered complicated and boring with a focus on getting right answers quickly (Holm, 2019), sometimes even generates a real fear of teaching this subject.

When listening to future teachers about what mathematics is and what mathematical activity is, their discourse has little to do with what mathematicians say. Mathematicians talk about problem solving, the connections between concepts and the world, and the beauty and complexity of mathematics; whereas, prospective teachers often talk about mathematics in terms of algorithms and correct answers, tips and tricks, and respect for Ministry requirements. But if it is these people who will help the next generation of children to learn mathematics, it seems important to think about the possibility of transforming their own mathematical experience and making a positive difference in what mathematics means to them.

It is by increasing the mastery of mathematical concepts needed by teachers and raising the level of pedagogy trust of future teachers that we can feed into a process of professional development that could lead them to offer rich paths as bearers of learning from the first mathematical concepts in primary school to the future.

It is precisely in this sense that this working group will be oriented on the following lines of reflection:

- How to advance the perspective of mathematics by future teachers? How to help them enrich and deepen their own understanding of this discipline?
- How to transform the mathematics conceptions of future teachers? How to encourage the development of a more authentic and positive relationship with the first mathematical concepts to be taught in primary school?
- How to change the meaning assigned by future teachers to learning and teaching the first mathematical concepts in primary school?

Orienting our working group through situations, tasks and reflections within these guiding questions, we will immerse ourselves in the first mathematical concepts to be taught in primary school and collectively aim to identify opportunities to (re) cultivate, in prospective teachers, a wonder and a curiosity about this beautiful and great discipline that is mathematics.

Suggested Readings:

Holm, J. (2018). Prospective teachers' conceptions of mathematics. In E. Bergqvist, M. Österholm, C. Granberg, & L. Sumpter (Eds.), *Proceedings of the 42nd conference of the International Group for the Psychology of Mathematics Education* (Vol. 5, p. 251). Umeå, Sweden: PME.

Holm, J. (2019, Jan.). Exploring the mathematical experiences and initial conceptions of future teachers. Presentation at Mathematics Education Forum. Fields Institute, Toronto, ON.

Kajander, A. (2010). Mathematics teacher preparation in an era of curriculum change: The development of mathematics for teaching. *Canadian Journal of Education, 33*(1), 228-255.

Morin, M-P., Theis, L., Rosa-Francoeur, J. (2012) Intégrer les connaissances mathématiques et didactiques : le cas de la formation en enseignement au préscolaire et au primaire de l'université de Sherbrooke. Dans J.L. Dorier et S. Coutat (dir.), Enseignement des mathématiques et contrat social : enjeux et défis pour le 21e siècle – Actes du colloque EMF2012 (GT1, pp. 195–205).

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

Working Group C *Leaders: Robyn Ruttenberg-Rozen, David Wagner & Ami Mamolo*	***Humanizing Data***

47% of Canadians aged 45 and over are grandparents. 14% of Canadians aged 15 and over live alone. 8.4% of Canadian families had less than $500 net worth in 2016. 1 in 5 workers in the top 1% are women. 24% of Canadians have hypertension. Data is ubiquitous; we are constantly bombarded with numerical information in the news, in our careers, in our day-to-day. What does data and its onslaught require of us as members of society in general, and in particular as members of CMESG? What is our response-ability as human beings? In exploring these questions, this working group will will comprise iterations of play and reflection. We will ask, among other things:

- What ***does*** it mean to humanize data and what ***could*** it mean to humanize data?
- How can we work with representations, models, statistics and probability that reflect known and unknown situations?
- How do we account for non-cognitive human experience in interpreting data?
- What is the difference between humanizing data for oneself and for others?
- What has been the societal role of data, and how might that change in the future?
- What is the role of authority and positionality in data representations and communication?

We model data. Data models us.

Working Group D *Leaders: Claudia Corriveau & Chris Suurtaam*	***Research & Practice: Learning Through Collaboration.***

Several research questions in mathematics education refer to a need for collaboration with teachers, but only few studies are guided by a real concern to take into account both the point of view of researchers and teachers to address them (Goos, 2014). This session considers the ways that research in mathematics education can acknowledge the reciprocal relationship between research and practice. Rather than a view of bringing research to practice we will also consider what it means to bring practice to research. Or rather, we will lean on a stance of inquiry (Cochrane-Smith & Lytle, 2009) to collectively discuss research that seeks to understand the complexity of teaching, and ways that researchers and teachers can work together to better understand issues that arise in mathematics education.

Collaboration can raise many challenges that should not be underestimated. In this working group, we invite you to explore not only the roles that teachers and researchers play when they collaborate, but also examine how this collaboration between research and practice in mathematics education can further enhance mathematics education.

Our discussions will include (but not be limited to) addressing the following questions:

- *Why would teachers and researchers get involved in collaborative research projects?*
- *What are ways to collaborate that rest one another's competencies, contexts, and perspectives?*
- *How can we design and implement collaborative projects whose results can be promoted in both scientific and practical worlds?*
- *What can be learned from a mathematical point of view in the collaboration?*

Participants will be encouraged to contribute to the discussion by providing examples of situations in mathematics education in which they collaborated.

Suggested Readings:

Bednarz, N. (2013) (dir.). *Recherche collaborative et pratique enseignante. Regarder ensemble autrement.* Paris : L'Harmattan.

Davis, B. (2005). Trois attitudes dans la recherche en éducation. *Revue des sciences de l'éducation*, *31*(2), 387-416.

Desgagné, S., Bednarz, N., Couture, C., Poirier, L. & Lebuis, P. (2001). L'approche collaborative de recherche en éducation: un nouveau rapport à établir entre recherche et formation. *Revue des sciences de l'éducation*, 27(1), 33-64.

Goos, M. (2014). Researcher-teacher relationships and models for teaching development in education. *ZDM Mathematics Education, 46*, 189-200.

Goos, M., & Geiger, V. (2006). In search of practical wisdom: A conversation between researcher and teacher. *For the Learning of Mathematics, 26*(2), 37–39.

Kieran, C., Krainer, K., & Saughnessy, J. M. (2013). Linking research to practice: Teachers as key stakeholders in mathematics education research. In M. A. Clements, A. Bishop, C. Keitel-Kreidt, J. Kilpatrick, & F. K.-S. Leung, *Third International Handbook of Mathematics Education* (pp. 361-391). New York, NY: Springer Science+Business Media.

Working Group E *Leaders: Jamie Pyper & Susan Oesterle*	***Interdisciplinarity with mathematics: Middle school and beyond.***

This working group will explore the opportunities and challenges of teaching and learning mathematics in an interdisciplinary context. To follow Staats (2014) this means "drawing a context from another discipline authentically enough to support learning in both disciplines" (p. 7). While the notion of interdisciplinarity is not new, contemporary promotion of STEM/STEAM, new mathematics curricula in which the "focus is on real-life, relevant contexts" (e.g., BC Math Curriculum, 2018), and ongoing efforts to foster mathematical literacy (OECD PISA, 2019) make this a timely focus for a CMESG working group. In our discussions and experiences of interdisciplinarity we will draw on underlying principles from mathematical problem solving, rich learning tasks, problem-based learning, context and situationality, cultural and Indigenous ways of knowing, and mathematical thinking and literacy, as appropriate.

We feel the middle grades (6 - 8) are well suited as a starting point for the exploration of interdisciplinarity with mathematics because a) the mathematics in the curriculum begins to permit richer contexts, b) classroom structures at this level typically still permit greater flexibility, and c) these years are often positioned by teachers, school systems, parents, and society, as a transition phase – finishing, closing out, and consolidating one phase of learning (the elementary school years) and moving into a second phase of learning (the secondary school years).

Over the three working group sessions: we will explore how we know and experience interdisciplinarity; examine our assumptions about the benefits and risks of teaching mathematics in an interdisciplinary context; engage in tasks that will help us understand some underlying principles to interdisciplinarity; and hopefully, through this, carefully, dis-integrate and then integrate our thinking about interdisciplinarity with mathematics.

References:

British Columbia Ministry of Education. (2018). BC Mathematics Curriculum Introduction. Retrieved from https://curriculum.gov.bc.ca/curriculum/mathematics/core/introduction

Frade, C., Winbourne, P., & Braga, S. M. (2009). A mathematics-science community of practice: Reconceptualising transfer in terms of crossing boundaries. *For the Learning of Mathematics, 29*(2), 14-22.

Lee, D. & Tosic, A. (2018, Fall). Teaching mathematics through global water issues. *Vector, 61*(2), 24-28.

OECD PISA Jan 31 2019. Mathematical Literacy. Retrieved from https://www.pisa.tum.de/en/domains/mathematical-literacy/

Staats, S. (2007). Dynamic contexts and imagined worlds: An interdisciplinary approach to mathematics applications. *For the Learning of Mathematics, 27*(1), 4-9.

Staats, S. (2014). The interdisciplinary future of mathematics curriculum. *For the Learning of Mathematics, 34*(2), 7-9.

Working Group F *Leaders: Darien Allan et Jean-Francois Maheux*	***Capturing Chaos? Lenses into the K-12 Mathematics Classroom***

There is a general consensus that the classroom is a multifaceted and often chaotic environment, which is experienced differently by each individual. This complexity makes authentically 'capturing' teachers' and students' experiences a difficult undertaking. There is the tension of scope: a simplistic or reductionist approach might yield results with limited applicability, whereas one too broad or complex seems unmanageable. Correspondingly, it is impossible to attend to everything, and as such any research method is to some extent limited (e.g., in the scope of what it can measure). Moreover, observations are never neutral: tools and stance always create their own 'realities', bringing forth phenomena and issues in their own language. Add in the spacial and temporal considerations, and undertaking classroom research can be overwhelming.

Yet understanding teachers' and students' experiences within this context is key to appreciating methods/curriculum/pedagogy, etc., (e.g., in terms of determining effectiveness), and a powerful precursor to making changes. If mathematics education is viewed as a "necessarily and beneficially an eclectic discipline" (Rowland, 1999, p. 5), then it is reasonable to infer that the field of mathematics education is enriched through the use of varied and multiple research methods. Rowland's view was significantly shaped by ethnography, but there are many other approaches that may prove fruitful (e.g., literary approaches). Over the past decades there has been a continual broadening of what constitutes classroom research – what methods are viable, valid, and credible. Chaos theory itself was occasionally solicited to conceptualize educational research methodologies designed to embrace classroom chaos: Louis Cohen, Lawrence Manion, and Keith Morrison (2009) proposed for example that "chaos and complexity theories argue against the linear, deterministic, patterned, universalizable, stable, atomized, modernistic, objective, mechanist, controlled, closed systems of law-like behaviour which may be operating in the laboratory but which do not operate in the social world of education" (2009, online). The goal for complexity theorists is to see chaos in a positive light, recognizing it as a fundamental condition for (mathematical?) life.

With the goal of cultivating an understanding of what takes place within the mathematics classroom this working group seeks to dig into questions such as:

· How do teachers and students experience chaos within the math classroom, and how should these experiences be of concern for mathematics education research?

· In the face of chaos, how do we deal with ideas such as subjective vs objective measures of classroom activity, the validity, credibility, affordances and limitations of teaching and research methods?
· Can we "capture" or make us of the complexity of what is happening in the math classroom? How can we work with/around the technical and theoretical constraints?
· What are possible implications of innovative and creative ways to understand, learn from, and communicate the chaos of the math classroom in terms of its "mathematical life"? How does it affect our way of thinking about doing mathematics in a teaching/learning context?

In the course of this working group, we will explore different ways to address the question of chaos in the mathematics classroom from a teaching, learning, and researching perspective. Participants will be invited to share their own experiences and insights on the issue, and will be presented concrete episodes of teaching, learning, and researching to further anchor our discussions on chaos.

A few references

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PANEL

Initiating and Nurturing Collaborations Between Mathematicians and Mathematics Educators
Frédéric Gourdeau: Chair
Panelists
Paul Deguire & Manon LeBlanc, Université de Moncton *Ed Doolittle*, First Nations University & *Kathy Nolan*, University of Regina *Ryan Gibara & Sarah Mathieu-Soucy*, Concordia University

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TOPIC SESSIONS

Topic Session A	***Culturally Sustaining Mathematics Education: Connecting Indigenous Knowledge and Western Mathematical Ways of Knowing***
Ruth Beatty; Lakehead University, Orillia & Colinda Clyne; Upper Grand District School Board	

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Topic Session B	***Relationships with/in/around Mathematics***
Florence Glanfield; University of Alberta	

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Topic Session C *Jérôme Proulx*, Laboratoire Épistémologie et Activité Mathématique Université du Québec à Montréal	Re-newing mathematics through students' ways of doing mental mathematics

In this topic session, I will present and analyze numerous students' strategies taken from studies conducted in mental mathematics contexts. Usually, in mathematics education, we attempt to understand how students make sense of mathematics by (implicitly, or at times, explicitly) comparing it with an external body of mathematics taken as a referent. Although this perspective has led us to many great insights on how students understand this mathematics and how we can think of ways to help them do this mathematics, I will not go down that route in this presentation and mainly attempt the inverse. Through analyzing these mental strategies, I will invite participants to consider what we can gain *mathematically* from these strategies, and how they can inform and inspire us about mathematics itself – what I call the *re-newing* of mathematics. These re-newings will be addressed as occasions to deepen our own mathematical understandings as a community, and will be discussed in terms of their outcomes for transforming school mathematics. Through the entire talk, an argument will be made that this perspective opens up a new research avenue for mathematics education, one focused on understanding students' work as a way of understanding mathematics itself and re-newing it.

Topic Session D *Keith Taylor, Dalhousie University*	**The Real Numbers – From Kindergarten to Signal Processing**

Mathematics has always been important to society as the basis for such activities as business accounting and the measurements involved in construction. With the emergence of the telegraph in the 1830s, the need for rigorous mathematical tools to analyze signals was a major contributing factor in the development of an understanding of the real number line and its properties. This was in place by 1900. But commercial radio, followed by television continued to incentivize research into the mathematical tools to analyze signals and images. In the late twentieth century, there was a massive acceleration in applications of real analysis, through signal and image processing, to society and culture. Think of the disruption to the music industry caused by mp3 compression, the incredible advances in medical imaging (MRI, CT, ultrasound), voice activated devices, facial recognition software, etc. There are many highly rewarding careers growing out of this revolution. I will argue that a strong understanding of the real number line can be achieved in more students through small modifications of curriculum. Such an understanding provides any student with an advantage as they prepare for a career in the modern economy.

NEW PHD SESSIONS
(ABSTRACT TRANSLATIONS PROVIDED BY THE SPEAKER.)

Robyn Ruttenberg-Rozen ***Institution: York University*** ***Supervisor: Lyndon Martin***	**Growth of mathematical understanding for learners who experience difficulties in mathematics**

A large proportion of learners experience difficulties learning mathematics. There is a growing body of research identifying and labeling those difficulties especially around computational fluency. At the same time, intervention research often explores accommodation type interventions for these learners, for example chunking information or creating step by step plans. Very little of this tells us how to support learners experiencing difficulties in understanding the mathematics. How do learners with great difficulty learning mathematics grow mathematical thinking? In this talk I discuss a case study of 3 learners in grade 5, all experiencing mathematics difficulties and their paths of growth of understanding of zero. I collected data during task-based interview sessions and mapped each learner's progression of understanding onto the Pirie Kieren Model of Mathematical Understanding. My research provides descriptive evidence of intervention specifically for growth in understanding, and results indicate how new understandings may be growing from acts of thickening and revisiting prior knowings.

Daniel Lumsden ***Institution: Ontario Institute for Studies in Education of the University of Toronto*** ***Supervisor: Douglas McDougall***	**Flipping The Secondary Mathematics Classroom: Teachers' Perceptions on the Use of Video Instruction**

The flipped classroom model is a pedagogical approach whereby teachers flip the sequence of instruction and homework. The purpose of this study was to explore teachers' lived experiences of flipped learning related to video instruction, critical thinking, and student engagement. A comparative case study design was employed using a conceptual framework combining, self-regulation theory, and self-efficacy theory.

Four secondary school mathematical teachers were selected for case studies. The findings and themes reported as strengths of video instruction included: flipped classroom engagement, student interactions, and mitigating learner challenges. The main three findings of this research are: (1) student-teacher relationships are strengthened; (2) students preferred a blend between the non-flipped classroom as well as a flipped classroom format; and (3) students benefited from having teacher-directed instruction at the beginning of class as a way to engage with the material.

Ayman Aljarrah ***Institution: University of Calgary*** ***Supervisor: Professor Jo Towers***	**Exploring collective creativity in elementary mathematics classroom settings**

In my study I aimed to explore and describe collective creativity in elementary mathematics learning environments. To fulfil the objectives of this study, I adopted a design-based research methodology. In my analysis of the data, the main source of which was video recordings of students' problem-solving sessions, I concentrated on the students' collaborative practices and how these contributed to the emergence of the new. Based on my analysis and interpretation of the data, I refined and (re)developed four metaphors to describe the experience of creativity with(in) the collective: summing forces, expanding possibilities, divergent thinking, and assembling things in new ways. Moreover, I determined four categories for features of mathematics learning environments that I believe were critical in the emergence of collective mathematical creativity: attendance to inquiry-based learning, cultivation of collaborative problem-solving, an engaging learning environment, and thoughtful, subtle interventions.

Olga Fellus ***Institution: University of Ottawa*** ***Supervisor: Barbara Graves***	**Teenagers at a crossroad: Exploring newcomer teenagers' identity as learners of mathematics and English as an additional language**

This PhD thesis was set to examine newcomer teenagers' identity as learners of mathematics in the context of their transition to the Canadian educational system. Drawing on Ricoeur's (1992) etymological distinction between *idem* and *ipse* (identity as sameness

and identity as selfhood), I aimed for a theoretical framework that allows for the investigation of identity as a dynamic concept. Such a framework is suggested by Ivanič (1998) who formulated four identity-related interconnected dimensions of (a) autobiographical identities, (b) authorial identities, (c) discoursal identities, and (d) socioculturally available selfhoods. The research design comprised three sets of data collection through family and individual interviews and focus group discussions. In total, six family interviews, 16 individual interviews, and two sets of all-parent and all-teenage focus groups lasting 90-minutes each yielded over 39 hours of data that were analyzed to explore the teenage newcomers' developing identities in the context of learning school mathematics.

Sarah Dufour ***Institution: UQAM*** ***Supervisor: Fernando Hitt et Caroline Lajoie***	**Understanding processes of the concept of derivative with a perspective on representations**

The concept of derivation has been the subject of many scientific studies in the field of mathematics education. Some of this research has proposed a theoretical framework to better understand students' understanding of the concept of the derivative. A contribution of my thesis work extends research in this direction. First, with the objective of modeling students' understanding of the derivative by looking at the process aspect of this understanding and setting up an analytical framework to describe or observe these processes. Then, by observing how the context in which the students will have been observed influences their understanding process.

On the theoretical level, a point of view on the use of different representations is adopted as a theoretical stance on understanding. In this perspective, the theoretical framework of this thesis is based on Duval's theory of semiotic representation registers (1988, 1993, 2006) and Hitt's functional representations (2003b, 2006). In order to set up a context to allow for the careful observation of student understanding processes, a *Teaching Experiment* (TE) was planned. The TE took the form of five teaching sessions that took place in parallel with a college-level differential calculus course involving six students.

**********end of program*****