CANADIAN MATHEMATICS EDUCATION STUDY GROUP

42ND ANNUAL MEETING

JUNE 1ST TO JUNE 5TH , 2018

ANNOUNCEMENT AND PROGRAM

We welcome you to Quest University Canada for the 42nd Annual Meeting of CMESG/GCEDM, which begins at 6:45 pm on Friday June 1st and ends at 12:30 pm on Tuesday June 5th.

We are delighted to welcome you to Squamish, British Columbia, the outdoor recreation capital of Canada, home to some of the world's best rock-climbing, windsurfing, mountain biking, and eagle watching. Squamish is also the traditional, ancestral, and unceded territory of the Skwxwú7mesh Nation.

Quest University Canada was founded by David Strangway, the former President of the University of Toronto (U of T) and the University of British Columbia (UBC). Since its opening in 2007, Quest has established itself as a leader in undergraduate liberal arts and sciences education, ranking #1 in all five measures of education excellence in the yearly National Survey of Student Engagement. Quest currently has an enrollment of 700, with students from over 40 countries.

To learn more about Quest University Canada, you can visit its website http://www.questu.ca. All on-campus CMESG events will be held either in the University Services Building (meals and plenaries) or the Academic Building (working groups and presentations). The Monday night closing dinner and dance party will be held at The Joinery (http://joinerysquamish.com), a recently-opened farm-to-table winery and restaurant located five minutes from the campus.

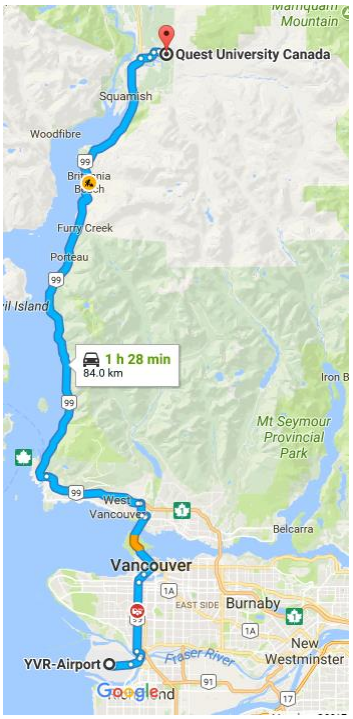
WELCOME AND REGISTRATION

Registration on Friday will be from 2:30 pm to 6:45 pm, in the first floor of the University Services Building, the same location as the opening session, plenary, and post-plenary reception. Dinner (at 5:00 pm) will be held in the top floor of the University Services Building, in the dining hall.

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. However, we will not be providing any mugs or bags, so we ask you to bring your own mug and bag.

All CMESG events will take place in Building #1 (University Services) and Building #3 (Academic) in the map below. Participants staying on campus will stay in Building #8 (South Village) or Building #12 (Red Tusk).

HOW TO GET THERE



Quest University is located in Squamish, a one-hour drive from downtown Vancouver.

The local organizing committee will organize a CMESG Carpool so that conference participants can get a ride from Vancouver to Squamish on Thursday May 31st and Friday June 1st, and from Squamish to Vancouver on Tuesday June 5th.

We encourage participants to join the CMESG Carpool, either as a driver or as a passenger. The pickup and dropoff locations will be Vancouver (YVR) Airport and Metro Vancouver.

For more information, please see the CMESG Registration Form.

For those of you who wish to travel to Squamish on your own, here are several options.

Taking The Bus

Book a bus to Squamish via Pacific Coachlines (http://www.pacificcoach.com) if you are coming from Vancouver Airport, or Greyhound (http://www.greyhound.ca) if you are coming from downtown Vancouver.

Pacific Coachlines costs $64 one-way, and will drop you off at the Squamish Adventure Centre. Greyhound costs about $15 one-way, and will drop you off at the Squamish Greyhound Terminal.

Once you arrive in Squamish, call Howe Sound Taxi (604-898-8888) to take you up to Quest University Canada.

Driving from Downtown Vancouver

1. Take Trans Canada Highway 1 / Upper Levels Highway and head towards the Horseshoe Bay Ferry Terminal.

2. At Horseshoe Bay Ferry Terminal, continue on Highway 99 North toward Squamish and Whistler.

3. Follow the Highway for approximately 44 km until you reach Squamish.

4. Continue past the town center. About 5 minutes after the town center is Mamquam Road (you will see a Canadian Tire on the North East Corner of Highway 99 and Mamquam Road).

5. Turn right (east) on Mamquam Road and continue for about 2 minutes.

6. Turn left (north) on Highlands Way and continue up the hill.

7. Once you have reached the top of the hill, turn right (east) on the Boulevard (also called University Boulevard).

8. Continue along the Boulevard up the hill and over the bridge until you reach Quest University Canada.

Driving from Vancouver International Airport

1. Look for destination signs leaving the airport terminal and follow Highway 99 North into Vancouver. You will pass over the Arthur Laing Bridge.

2. Take the ramp towards Granville Street / City Centre.

3. Follow Granville Street and head north for approximately 7 km. Cross over the Granville Street Bridge.

4. Take the far right lane on the bridge and take the Highway 99 North / Seymour Street ramp.

5. Staying straight on Seymour Street until you turn left onto West Georgia Street / Route 99.

6. Continue on West Georgia Street past Stanley Park and head over the Lions Gate Bridge.

7. Exit the bridge onto the Marine Drive West / Provincial Route 99 North. Once on Marine Drive take the far right lane.

8. Turn right onto Taylor Way / Provincial Route 99 North.

9. Travel up the hill, under the Highway then take a left so as to merge onto the Trans Canada Highway 1 / Upper Levels Highway towards Horseshoe Bay / Squamish / Whistler.

10. At Horseshoe Bay Ferry Terminal, continue on Highway 99 North toward Squamish and Whistler.

11. Follow the Highway for approximately 44 km until you reach Squamish, and then proceed with the same directions as written above.

PARKING

Parking is free. If you'd like to leave your car at Quest overnight, please park your car in the lot between Buildings #7 and #8 in the map below.

ACCOMMODATIONS

We have reserved a block of rooms in two of Quest's residences.

Accommodations in Red Tusk (Building #12) consist of a pair of single rooms connected by a shared washroom. The rental rate is $80.00 per night for a 2-bedroom unit with 1 shared washroom, i.e., $40 a night if you are sharing with someone.

Accommodations in South Village (Building #8) consists of 2 bedrooms and 2 bathrooms, with a large common space between bedrooms. These units can accommodate up to 4 people with 2 twin beds per bedroom. The rental rate is $141.50 per night, i.e., just over $35 a night if you are sharing with three others, or $70.75 a night if you are sharing with one other person.

For more information on the accommodation options, please see https://questu.ca/public-opportunities/facilities-rentals/.

All guest room rates are subject to GST and PST rates in effect at the time of the event.

To book your accommodation, contact Quest Conference Services by phone at 604-898-8110 or via e-mail at conference@questu.ca. When contacting them, mention that you are part of the Canadian Math Education Conference.

For those of you wishing to stay at a hotel, here are several options in Squamish, all of which are a short drive to campus, roughly 5 to 10 minutes.

Best Western Mountain Retreat Hotel & Suites
Quest rate: $79.99
38922 Progress Way, Squamish, BC
604-815-0883 or 1-866-686-7387
www.squamishmountainretreathotel.com

Howe Sound Inn and Brewery
Please call for special Quest rate
37801 Cleveland Avenue, Squamish, BC
604-892-2603 or 1-800-919-ALES
www.howesound.com

Executive Suites Hotel & Resort
Quest rate starting at $109
40900 Tantalus Road, Garibaldi Highlands, BC
1-877-815-0048
www.executivesuitesgaribaldi.com

Sandman Suites
Quest rate $89 (includes breakfast)
39400 Discovery Way, Squamish, BC
604-848-6000 or 1-800-726-3626
www.sandmanhotels.com/hotel/bc/squamish

MEALS

All lunches and dinners will be taken with the group, except for dinner on Saturday (which will be dinner on your own). On Saturday night, a free shuttle bus will drive CMESG participants from Quest to the Garibaldi Estates area of Squamish, where there are plenty of local restaurants.

Breakfast will be offered each day in the Quest Dining Hall. If you wish to take advantage of this option, you may purchase your breakfast each morning on your own (a la carte) or pay for a breakfast voucher ($10 a day) which will give you a hot breakfast with unlimited coffee and tea.

EXCURSIONS

There are two possible Sunday afternoon excursions. You have the choice of selecting either a trip to an award-winning Britannia Mine Museum followed by a brief view of Shannon Falls Provincial Park, or a trip up the recently-opened Sea to Sky Gondola.

For more information, please check out the following links.

Britannia Mine Museum and Shannon Falls Provincial Park

http://www.britanniaminemuseum.ca/
http://seatoskyparks.com/parks/shannon-falls/

Sea to Sky Gondola

http://www.seatoskygondola.com/

EMERGENCY

In case of emergency during the conference, you can contact Richard Hoshino at 604-848-5503 or by e-mail at richard.hoshino@questu.ca. The university also has a security service available at 604-389-8086. Please use this number for all emergencies.

FEES

The conference fee ($ 210 if registration is received by April 13th 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 June 1 15h30 – 16h20. Multi-Purpose Room

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 Olive Chapman at 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.

PLENARY LECTURES

Lecture I ***Donald Violette*** *Université de Moncton*	***What if we teach passion?***

Two adages have always guided me since my first steps in the world of mathematics:

- "Nothing gets accomplished in this world without passion" and
- "To be more than to appear".

These two adages have led me to question my teaching practices from my very first year of teaching in a university setting. I have quickly understood that a professor should not only transmit knowledge, but also passion. Passion is contagious; it is communicative and makes the courses more interesting, more lively and more stimulating.

I had dreams: to coordinate high-level intellectual activities for talented francophone students in New-Brunswick and to publish a novel for youth in which mathematics would be at the heart of the plot. These dreams became reality by establishing, among other things, three competitions, three mathematics camps and a mathematical foundation –the first and only one in Canada– that encompasses all of my projects for youth. In addition, my book "Mathémagiciens" was launched in March 2017.

In this conference, I will talk about my passion, my dreams, my projects, my unique way of teaching, my love for teaching and for youth, etc.

Lecture II ***Merrilyn Goos*** *University of Limerick*	***Making connections across disciplinary boundaries in preservice mathematics teacher education.***

Prospective teachers of mathematics need both subject matter knowledge and pedagogical content knowledge – in other words, they need to know not only the content but also how to teach it. In most initial teacher education programs these two kinds of knowledge are usually taught in separate courses, designed and delivered separately by mathematicians (content) and mathematics educators (how to teach the content). Consequently, few opportunities exist to interweave content and pedagogy in ways that cultivate professional knowledge for teaching. This presentation will draw on a national project that developed strategies for combining knowledge of mathematics content and pedagogy by fostering genuine, lasting collaboration between communities of mathematicians and mathematics educators in six Australian universities.

Data sources included two rounds of interviews with mathematicians and mathematics educators and annual reports prepared by each participating university over the three years of the project. The study identified interdisciplinary boundary practices that led to integration of content and pedagogy through new courses co-developed and co-taught by mathematicians and mathematics educators, and new approaches to building communities of pre-service teachers. It also developed an evidence-based classification of conditions that enable or hinder sustained collaboration across disciplinary boundaries. The study additionally highlighted the ambiguous nature of boundaries and implications for brokers who work there to connect disciplinary paradigms.

WORKING GROUPS

Working Group A *Leaders: Jérôme Proulx and Peter Taylor*	***What mathematics curricula for the 21st century at the secondary-level? (7-16).***

In the 50s and 60s, major projects at the international level sought to develop new curricula in mathematics. The objective seemed to be to modernize (update) the teaching of mathematics and to enable students to better adapt to the challenges of the years to come (Moon, 1986). Now, 60-70 years after these events, it seems worthwhile to start a similar exercise of reflection on the modernization of our curriculum for the 21st century both short-range for the next few years and long-term for the coming decades.

The purpose of the working group is to launch this project among the members of CMESG. We plan to focus the discussion at the secondary level (grades 7-12), paying attention to its impact at the tertiary level.

As with any working group at the GCEDM, the work of the WG will be greatly influenced by the commitment and interest of the participants. The co-leaders will propose various activities to the participants (mathematical, didactical, philosophical) designed to explore, both at the conceptual and the concrete level, the nature of school mathematics.

Focusing on the secondary-level mathematics classroom, we will reflect as much on questions of content as on questions of pedagogy and didactics, that is, what should we teach and how should we teach it. The following questions will thus guide the group's work (note that the verb “should” is used here not in its prescriptive sense, but more at the reflective level, since the working group is intended to be an open flexible space).

> 1a-From the university point of view, what “should” be the content of HS math for the 21st century?

1b-From the High School point of view, what "should" be the content of HS math for the 21st century?

2a-From the university point of view, what "should" be the way of teaching mathematics in HS for the 21st century?
2b-From the High School point of view, what "should" be the way of teaching mathematics in HS for the 21st century?

In grappling with these questions we will be balancing two objectives, the quality of the students' daily experience, and the need to prepare them for university and college.

References

Moon, B. (1986). The 'new maths' curriculum controversy: an international story. Falmer Press: UK.

Working Group B *Leaders: Lisa Lunney Borden and Gale Russell*	***Confronting Colonialism in Mathematics and Mathematics Education. (K-16)***

This working group will focus on decolonizing mathematics and mathematics education. In order to do this, we must first recognize how colonialism operates within these fields that have far too often enjoyed a myth of being culturally neutral. Gutiérrez (2017) has argued, "School mathematics curricula emphasizing terms like Pythagorean theorem and pi perpetuate a perception that mathematics was largely developed by the Greeks and other Europeans" (p. 17). This idea of course is not new; scholars have been writing about this for decades (Ascher & Ascher, 1997; Bishop, 1990; Harris, 1997; Lumpkin, 1997). Yet despite this obvious Eurocentric focus, mathematics is often presented as culturally neutral and value free. The mathematics content however, is not the only site of artefacts of colonialism within mathematics education. Pedagogical and assessment choices frequently made in mathematics classrooms also continue to reflect colonial values (Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009).

As a settler state, Canada continues to experience and engage in settler colonialism which is about occupying land to make it the home for settlers, and "In order for the settlers to make a place their home, they must destroy and disappear the Indigenous peoples that live there" (Tuck & Yang, 2012, p. 5-6). Canada's residential school system was designed to do just that, to erase Indigenous Peoples from the Canadian landscape and destroy their relationship to the land through cultural genocide (Truth and Reconciliation Commission (TRC), of Canada, 2015) The TRC calls to action call upon educators and others to address the impact of colonialism on Indigenous Peoples in Canada as well as the processes of colonialism that

continue to operate throughout Canadian society. The TRC calls to action are now a primary focus in many educational institutions across the country, and as such, it is important to consider how mathematics education can respond to these calls. It is also important to recognize that colonialism impacts other populations here in Canada, in particular Canadians of African descent, and populations around the world.

To develop a greater awareness of colonialism and the process of decolonizing mathematics and mathematics education, our working group will examine three related ideas:

1. How do we recognize the processes and artefacts of colonialism in the classroom? What do they look like and feel like? How is colonialism experienced by students, particularly those who have been historically marginalized by our system?
2. What are the ways in which we can unlearn and disengage from colonialism? How might we challenge colonial discourses and promote counter-narratives in our mathematics classrooms and mathematics and education departments and faculties?
3. How can we support educators at all levels to recognize and challenge colonialism in their own classrooms? How can educators decolonize their classrooms?

References

Ascher, M., & Ascher, R. (1997). Ethnomathematics. In A. B. Powell, & M. Frankenstein (Eds), *Ethnomathematics: Challenging Eurocentrism in mathematics education* (pp. 25-50). Albany, NY: State University of New York Press.

Bishop, A. J. (1991). *Mathematical enculturation: A cultural perspective on mathematics education.* Dordrecht, NL: Kluwer Academic Publishers.

Greer, B., Mukhopadhyay, S., Powell, A. B., & Nelson-Barber, S. (2009). *Culturally responsive mathematics education.* New York, NY: Routledge.

Gutiérrez, R. (2017). Political conocimiento for teaching mathematics: Why teachers need it and how to develop it. In S. E. Kastberg, A. M. Tyminski, A. L. Lischka, & W. B. Sanchez (Eds.), *Building support for scholarly practices in mathematics methods* (pp. 11–37). Charlotte, NC: Information Age.

Harris, M. (1997). An example of traditional women's work as a mathematics resource. In A. B. Powell and M. Frankenstein (Eds.), *Ethnomathematics: Challenging Eurocentrism in mathematics education* (pp. 215 – 222). New York: State University of New York.

Lumpkin, B. (1997). Africa in the mainstream of mathematics history. In Powell, A. B., & Frankenstein, M. (Eds.), *Ethnomathematics: Challenging Eurocentrism in mathematics education* (pp. 101-117). Albany, NY: State University of New York Press.

Truth and Reconciliation Commission, of Canada. (2015). In Truth and Reconciliation Commission of Canada, issuing body (Ed.), *Final report of the Truth and Reconciliation Commission of Canada. Volume one, summary : Honouring the truth, reconciling for the future* ([Second printing]. ed.). Toronto: Toronto: James Lorimer & Company Ltd., Publishers.

Tuck, E. & Yang, K.W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education and Society*, 1(1), 1-40.

Working Group C *Leaders: Stéphane Cyr and Ralph Mason*	***Playing with mathematics/Learning mathematics through play. (K-12)***

Predominantly in today's discourses, both doing mathematics and learning mathematics is described as « hard work ». But what if the nature of mathematics was much more playful than the nineteenth-century work ethic of the last 200 years has portrayed it?

Many theorists advocate the use of games and their effectiveness have been demonstrated by several studies on the subject. When used well in class, play-based practice makes it possible to orient pupils towards a motivating, pleasure generating activity in which they engage freely with interest. Through play, the teacher has more time and opportunities to observe the students' different learning processes. In recent years, educational video games have come to enrich the universe of learning-oriented mathematical games. As a result, many studies have recently found positive effects of this tool on student learning in the classroom.

Yet, despite the increased use of technology among younger generations and the positive effects of educational video games on learning and motivation, many teachers remain skeptical about its relevance to facilitating learning in the classroom. Part of the reason for this mistrust is that there are few models and strategies for assisting teachers in the effective use of video games in the classroom. Also, the available knowledge of teachers' pedagogical roles to facilitate video game learning is, at present, still very limited. However, even with well-designed video games, teachers have a fundamental role to play in maximizing the effectiveness of this tool in the classroom. In particular, they can guide students in different ways to orient their reflections towards learning objectives related to the curriculum, identify "learning moments" during play, or anticipate potential barriers to learning and to students' motivation.

In this working group (oops—make that "playing group"!), several aspects regarding play (video game and mathematical game) in primary school will be debated and different activities will be carried out:

a) Strategies for integrating play into the classroom
b) Consideration of play in the school curricula
c) Exploration of educational games relevant for learning
d) Scientific experiments on the effectiveness of educational games in the classroom
e) Purpose of educational video games in the classroom
f) Training for future teachers on the use of educational videos games in the classroom
g) A different approach: kinds of interactions between games and math learning.
h) Deductive reasoning and logic games
i) Games as foundational experiences for mathematical content
j) Games as contexts for practicing arithmetic
k) Games of chance and probability

l) Games that simulate mathematics
m) Math games as weight-lifting for the brain
n) The math in games: analyzing games mathematically

Working Group D *Leaders: Krista Francis, France Caron, and Steven Khan*	***Robotics in mathematics education.***

Robots and robotics have spread out of research laboratories, industrial and commercial settings to a variety of new locations including living rooms and classrooms. This incursion has afforded different learning opportunities for children and adults. As Papert (1993) called educational robots 'objects-to-think-with,' we wish to explore some of the potential for using robots to think about mathematics and other powerful ideas from allied disciplines through engaging with building and programming. Our K-12 exploration will be done through playing with, building, and programming robots.

We expect that our working group might attend to some of the following:

- didactical and pedagogical questions such as: What can be gained with robotics in terms of learning mathematics? What might a learning trajectory for educational robotics in mathematics education look like? What do we know about teaching robotics and teaching mathematics with robots? What don't we know? What sorts of tasks have good ratio costs:learning? How can we build on teacher knowledge for teaching mathematics with robots? How can we support parents in engaging their kids with robots? Is 'playground versus playpen' (Bers, 2018) an appropriate metaphor to capture affordances and implications of robotics in education? Are there other frameworks we should consider (e.g. modelling, computational thinking)?
- practical issues such as selection, cost, maintenance, and storage of educational robots K-8.
- political and social issues such as addressing equity and opportunity gaps, impact on labour, robot companions and tutors.
- philosophical issues such as the ethics of human-robot interactions in the early years and beyond. In a nutshell, what does it mean to be human / do mathematics in an age of intelligent machines?

Readings:

Bers, M. U. (2018). Coding as a playground. Programming and computational thinking in the early childhood classroom. New York, NY: Routledge.

Blikstein, P., & Wilensky, U. (2007). Bifocal modeling: a framework for combining computer modeling, robotics and real-world sensing. In *annual meeting of the American Educational Research Association (AERA 2007), Chicago, USA*.

Francis, K., & Poscente, M. (2016). Building number sense with Lego® robots. Teaching Children Mathematics, 23(5), 310–314.
Papert, S. (1993). Mindstorms : children, computers, and powerful ideas. New York: Basic Books.

Participants will need to download the EV3 Mindstorms software on a laptop or tablet
https://www.lego.com/en-us/mindstorms/downloads/download-software

Working Group E *Leaders: Sean Chorney, Alf Coles and Nathalie Sinclair*	***Relation, ritual and romance: Rethinking interest in mathematics learning. (K-12)***

In this working group, we have as our background concern the challenge of evoking and sustaining interest in the mathematics classroom, interest that is mathematical in its focus (rather than a lure into mathematics). We will come at this concern by working with three concepts that have some historical connections to the topic of mathematical interest, but that also provide new and productive ways of engaging it. These concepts are: ritual, romance and relation. By ritual we want to foreground the classroom-wide establishment of interest that arises from working on mathematical objects in a communal and sometimes even chant-based manner. By romance we draw on Whitehead's argument that it is in the stage of romance that we can develop interest, which is necessary for attention and apprehension. Finally, by relation we want to re-think the assumption that student interest begins in the concrete/real-life and investigate ways in which a relational approach to mathematics concepts may also provide students with opportunities for form their own relations with mathematics.

Questions:

- What kinds of activities can highlight romance and ritual to create mathematical interest?
- What are ways we can interest learners in a mathematical activity that does not necessarily rely on previous and/or personal student experiences?
- Does ritual have an underlying material beat or spirituality?
- How can we think of ritual as a way of engaging all students together in a collective practice?
- How can we re-think interest as not only steps toward but also as constitutive of learning?

TOPIC SESSIONS

Topic Session A	***What my grandson taught me about learning mathematics.***
Malgorzata Dubiel, Simon Fraser University	

My grandson Liam is 2 1/2 years old. Since he was born, I have been observing him as he struggles to learn the skills he needs, and as he discovers the world around him. While as a mathematician I know that I should not make generalizations based on a sample of one, these observations do lead to a few conclusions.

It seems that we are biologically programmed to learn. We like to practise, and to keep practising until we master things. Then we like to show proudly our accomplishments (and enjoy the praise). Then we look for new things, new challenges. We are not concerned with our limitations, real or imagined. And we definitely don't feel any math anxiety.

In this talk, I would like to share some of my observations on Liam's learning of math concepts, abstract reasoning and language. Then I would like to invite a discussion on how we can help all children to retain this excitement and drive to learn throughout their lives, and on how/if we can help those who have lost the desire to learn – or, possibly, the faith that they can, which is not that uncommon in relation to mathematics – to regain it. I will share some success stories from our efforts at Simon Fraser University.

Topic Session B	***Problems with Numbers: A College Perspective.***
Taras Gula, George Brown College	

The college context for teaching foundations mathematics presents unique challenges to teachers. I will describe this context and demonstrate how this context along with research on teaching and learning in the college setting has spawned an interest in reimagining the first-year college foundations mathematics course as a course in numeracy. I will also attempt to demonstrate that in the college setting the instructional design approach that makes most sense is one that uses multiple theoretical perspectives and can best be categorized as *systematic eclecticism* (Ertmer & Newby 2013). It is this approach that has been used in developing learning content for an on-line learning tool in a SSHRC funded research project titled the Health Numeracy Project.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, Cognitivism, Constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, *26*(2), 43–71. https://doi.org/10.1002/piq

Topic Session C *Viktor Freiman, Université de Moncton*	***Learning mathematics in technology-rich environments: how disciplinary competences interact with so-called 'soft-skills'***

Since the beginning of the 21st century, new learning spaces, rich in digital technologies, have given a boost to numerous initiatives in schools. For example, in New Brunswick, several studies were conducted: one-to-one access to laptops (Freiman et al., 2011), robotics-based learning (Savard and Freiman, 2015), mathematical problem solving in a virtual learning community (Freiman and DeBlois, 2014) and, more recently, makerspaces (digital manufacturing labs) (Freiman et al., 2017), and computer programming (Djambong et al., 2017). In addition to creating new opportunities to enrich and eventually transform student learning, these innovative practices highlight a complex dynamic of interactions between disciplinary learning (in mathematics) and new types of skills called 'non-technical' (21st century, or soft-skills). In my presentation, I will share our research data that sheds light on both the benefits and challenges of these changes regarding their appropriation by the educational community.

Topic Session D *Elaine Simmt, University of Alberta*	***Using complexity thinking in mathematics education research.***

How can complexity thinking contribute to understanding the teaching and learning of mathematics? In classroom-based research I conducted many years ago I was interested in the implications of high activity mathematics in a grade 7 class. Complexity theory provided me and my colleagues ways to think about that question. We began with using complexity concepts to describe the classroom dynamics from which mathematics emerged (Davis & Simmt, 2003). Then we deliberately discussed and used complexity thinking when working with teachers in professional development contexts (Davis & Simmt, 2006). In more recent years, complexity has underpinned two other areas of our work: a deliberate attempt to create tools and methodologies for observing learning in collective and complex learning systems (Simmt, 2015; Mc Garvey et al. 2015; Mc Garvey et al., 2017; Mgombelo, 2017) and capacity building work in the context of development projects (Simmt et al., 2018). In this session I will explain how my colleagues and I have used complexity thinking for observing, understanding and designing mathematics education experiences in the context of small groups, class-sized groups and multi-group projects.

Davis, B. & E. Simmt. (2003). Understanding Learning Systems: Mathematics Education and Complexity Science. *Journal for Research in Mathematics Education 34*(2), pp. 137-167.

Davis, B. & E. Simmt. (2006). Mathematics-for-teaching: An ongoing investigation of the mathematics that teachers (need to) know. *Educational Studies in Mathematics 61*(3), pp. 293-319.

Mgombelo, J (2017). Collective Learning: Re-thinking the Environment, Artifacts. Topic Group Session, CMESG, McGill, Montreal, QC.

McGarvey, L., Davis, B., Glanfield, F., Martin, L., Mgombelo, J., Proulx, J., Simmt, E., Thom, J., Towers, J. (2015). Collective learning: conceptualizing the possibilities in the mathematics classroom. Proceedings of the 37th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education. East Lansing, MI: Michigan State University.

McGarvey, L., Glanfield, F., Simmt, E., Towers, J., Davis, B., Martin, L., Proulx, J., Mgombelo, J., Thom, J., Luo, L. (2017). Monitoring the Vital Signs of Classroom Life, Paper presented at the National Council of Teachers of Mathematics Research Conference, San Antonio, TX.

Simmt, E. (2015). Observing collective learning systems. In Bartell,T.G., Bieda,K.N., Putnam,R.T., Bradfield,K. & Dominguez, H. (Eds.). (2015). Proceedings of the 37th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education. East Lansing, MI: Michigan State University.

Simmt, E., Binde, A., Glanfield, F., Mgombelo, J. (2018). Building Complexity into Development Projects: A Case Study. Paper presented at Field's Education Forum, Toronto, ON.

Topic Session E	***Rethinking Teaching Year 1 Mathematics in University.***
Miroslav Lovric, McMaster University	

I will report on several attempts at identifying alternatives to present-day teaching of mathematics and statistics to year 1 university students. As a possible theoretical framework to support necessary curricular changes I propose an enhanced version of *mathematical habits of mind* (Cuoco et al., 1996). My presentation will be informed, in part, by an analysis of data from the newly created First Year Mathematics Courses Repository database. I will discuss my efforts and experiments with year 1 mathematics curriculum, which include: investigating possibilities of replacing calculus for students who have to take only one university mathematics course with a true applications-based, active-learning numeracy course; integrating computational thinking into the two life sciences mathematics courses we are offering at McMaster; and modifying an existing "proofs course" into a user-friendly math survival course, with the help of a MOOC.

Cuoco, A., Goldenberg, E. P., & Mark, J. (1996). Habits of mind: An organizing principle for a mathematics curriculum. *Journal of Mathematical Behavior, 14*(4), 375–402.

Topic Session F *Nadia Hardy, Concordia University*	***Reflections around the notions knowledge(-to-be)-taught and knowledge(-to-be)-learned from the Anthropological Theory of the Didactic – Challenges for researchers and for teachers.***

Summary: Over the last few years, we (graduate students under my supervision and I) have been inquiring into 'what undergraduate students (don't) learn in … [calculus / introductory analysis courses]'. In doing so,

- we are constantly reflecting on the different stages of the process of didactic transposition (quickly stated: the process by which knowledge is transposed from scholar knowledge to teachable/learnable knowledge), and
- we construct (praxeological) models of students' knowledge based on different pieces of data.

In this presentation, I share these reflections and some considerations regarding the (non)linearity of the didactic transposition process in the particular case of teaching and learning at the university level. I then delve into the challenges of building models of students' knowledge and gathering data to do so. I share examples of the models and methodologies we use. Finally, I address questions raised by university professors, who have been involved in our research (as researchers, reviewers, participants, observers), regarding the role and relevance of the models we build – what these *mean* to them.

NEW PHD SESSIONS

(ABSTRACT TRANSLATIONS PROVIDED BY THE SPEAKER.)

Priscila Corrêa ***Institution: University of Alberta*** ***Supervisor: Dr. Elaine Simmt***	***High-school students' mathematical understanding and proficiency in the context of mathematical modeling.***

Due to the benefits of the use of mathematical modeling in mathematics classes, modeling is becoming more common and more appealing to secondary mathematics teachers. However, there are still unanswered questions and conjectures to be explored, so as to aid and encourage mathematics teaching through modeling. The present study uses classroom-based research to investigate what forms of mathematical understanding and proficiency are observed and how they are expressed when high-school students are engaged in mathematical modeling tasks. The research methodology is founded on design-based research, which combines theoretical

research knowledge and practical experiences, yielding practical knowledge. The classroom design framework is based on complexity science underpinnings. Data analysis was conducted using a model of mathematical proficiency. Research outcomes indicate that mathematical modeling tasks promote students' mathematical understanding and proficiency, being a potential resource in the teaching for understanding without hindering curriculum goals or wasting classroom time.

Mahtab Nazemi ***Institution: University of Washington, Seattle*** ***Supervisor: Dr. Kara Jackson***	***Racialized Narratives of Female Students of Color: Learning Mathematics in a Neoliberal Context.***

This talk brings together sociocultural theories of learning and identities with critical race theory to examine the racialized narratives of six female students of color who were enrolled in an AP Statistics classroom, characterized by high-quality implementation of equity-oriented instruction and taught by a race-conscious teacher. In this talk, students' narratives will help to uncover and demonstrate some ways in which female students of color negotiate and navigate their various intersecting identities while learning mathematics. Additionally, racialized and meritocratic discourse are juxtaposed against their larger social context of institutional racism and neoliberalism. This talk will conclude with important implications for teachers and teacher educators, such as inquiry into the salience of – and engaging in conversation around – race and racism for mathematics teaching and learning. This includes questioning assumptions regarding ability, as well as meritocratic and race-neutral discourse around success.

Mina Sedaghat Jou ***Institution: Simon Fraser University*** ***Supervisor: Dr. Stephen Campbell***	***Mathematical Tool Fluency: Learning Mathematics Via Touch-based Technology***

Recent advances in the study of mathematics embodiment have given rise to renewed interest in how mathematical learning relates to our bodily actions and the sensorimotor system. In this dissertation, I explore the embodiment of mathematics learning with a particular focus on the relationship among gestures, hand and finger movements, and the use of mathematical tools. The theoretical lens of perceptuomotor integration enabled me to articulate mathematics learning through the development of tool fluency within a non-dualistic view of mathematical tools.

The dissertation is structured as three stand-alone descriptive case studies that adopt Husserl's phenomenological attitude in analysing participants' lived experience while using mathematical tools. Drawing on the work of Nemirovsky, one of the main intentions is to provide a thick description of learners' perceptual and motor activities, which may result in the emergence of perceptuomotor integration in Husserlian experiential time.

The results provide evidence for a high degree of gestural and bodily engagement while learning, communicating, and playing with mathematical tools. For example, in the first study, we discuss the process of learning cardinality for a young child in the context of mathematical explorations with a multimodal iPad application named *TouchCounts*. We are identifying the development of 'finger-touching' action while the child is playing with it. In the second study, I present and discuss the notions of 'active sensation' and 'tactile perception,' in the context of a blind undergraduate student explaining the behaviour of a rational function. In the third study, which involves a prospective teacher identifying types of geometric transformation in a touchscreen geometry software (Geometer's Sketchpad (GSP) on iPad), I identify new modes of Arzarello's active interactions. Identifying, analysing, and exploring different modes of interactions with touchscreen-based mathematical tools leads me to propose a new methodological approach for analysing video data. This methodological approach enabled me to catalogue interactions in order to monitor and assess the emergence of mathematics expertise while the learner interacted with the mathematical tool.

Keywords: learning; touchscreen-based technology; cardinality; visually impaired; prospective teacher; geometric transformation; tool fluency; fingers

Jeffrey Truman

Institution: Simon Fraser University
Supervisor: Dr. Rina Zazkis

Mathematical Reasoning Among Adults on the Autism Spectrum: Case Studies with Mathematically Experienced Participants

I investigate the unique or unusual characteristics of mathematical problem-solving among adults on the autism spectrum by conducting and analyzing three case studies. The case studies involve providing individuals with a variety of mathematical problems divided into four main groups: paradoxes of infinity, problems emphasizing algebraic or geometric solution, probability, and logic and proof. Participants are given individual interviews, intended to facilitate the communication of their thought processes when solving these problems. Results are analyzed with a variety of constructs, from a perspective that is rooted in Vygotskian ideas and supportive of neurodiversity.

Darien Allan ***Institution: Simon Fraser University*** ***Supervisor: Dr. Peter Liljedahl***	***Student Actions as a Window into Goals and Motives in the Secondary Mathematics Classroom***

Students come to the secondary mathematics classroom with a variety of motives. These motives shape the goals a student holds, the actions that a student performs within the classroom, and ultimately the approach a student takes towards learning. The research presented in this thesis looks closely at student actions in high school mathematics classrooms with the aim of identifying student goals and motives, and further, analysing the relationships between students' actions and their motives.

Using an ethnographic perspective and methods, in situ interviews and observations were conducted in three classrooms. Actions in activity settings were catalogued and analysed, then, using classical activity theory, 10 students' actions and goals in multiple activity settings were analysed to ascertain his or her motives in mathematics class. A 'crossover' approach revealed that similar student actions can be driven by different motives, and that the same motive does not always manifest in similar student action.

Lauren DeDieu ***Institution: McMaster University*** ***Supervisor: Dr. Megumi Harada***	***Incorporating Mathematical Writing into a Second Year Differential Equations Course.***

Incorporating mathematical writing into the curriculum can be an incredibly value tool. In addition to helping students better understand course content, precise mathematical writing can train students to become logical thinkers and construct rigorous arguments. It can also teach students how to effectively communicate complex ideas to non-experts.

The setting of this study was a second-year differential equations class which contained assignments which emphasized writing quality over mathematical correctness. We explored whether students believed that the written assignments were an effective learning strategy and asked whether or not they believed that working on the assignments led to enhanced communication skills. We also analyzed the extent to which students' pre-existing beliefs may have contributed to these attitudes. Since psychological determinants can have a strong impact on student learning, the hope is that these insights can help instructors frame writing assignments in a way that will help achieve their desired learning outcomes.

Diane Tepylo ***Institution: OISE/University of Toronto*** ***Supervisor: Dr. Joan Moss***	***Examining changes in Spatialized Geometry Knowledge for Teaching as early years teachers participate in adapted Lesson Study.***

Research suggests there is a crucial need to improve the teaching of geometry and spatial reasoning in early years classrooms; however, limited teacher knowledge of geometry and spatial reasoning are noted to be significant challenges to this goal. This case study investigated five teachers' learning about spatialized geometry when participating in an adapted lesson study which included clinical interviews, exploratory lessons, and resource creation. During the course of the adapted lesson, the teachers demonstrated substantial expansion of their spatialized geometry knowledge for teaching (SGKT)—a new concept that encompasses learning about students and teaching as well as about specific geometry concepts. The substantial teacher learning in this case study suggests that the potential of adapted lesson study to address the issue of limited geometry knowledge typically found in early years teachers.

Kitty Yan ***Institution: OISE/University of Toronto*** ***Supervisor: Dr. Gila Hanna***	***Key Ideas In Proof In Undergraduate Mathematics Classrooms***

The mathematics education literature reveals an ongoing interest in fostering students' ability to construct and reconstruct proofs. One promising tool is the concept of "key idea". This study investigated how undergraduate mathematics students identify the key ideas in a proof and use them in reconstructing it.

The findings show that while most of the students reported that they consciously identified key ideas in proofs, they varied widely in their understanding of the concept itself. Very few students were able to use precise language and point to an idea that helped them both understand the proof and reconstruct it.

The findings suggest that mathematics educators, in their desire to see students enhance their understanding of proof and proving by the use of key ideas, will need to extend considerable support to students by actively intervening to draw their attention to features of proofs that are candidates for key ideas.

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