CANADIAN MATHEMATICS EDUCATION STUDY GROUP

38TH ANNUAL MEETING

MAY 30 TO JUNE 3, 2014

UNIVERSITY OF ALBERTA

ANNOUNCEMENT AND PROGRAM

We're happy to welcome you to the University of Alberta for the 38th Annual Meeting of CMESG, which opens at 1845 on Friday May 30 and closes at 1230 on Tuesday June 3.

University of Alberta is located in Edmonton, capital of Alberta. Set atop the North Saskatchewan river valley, the University overlooks North America's largest urban green space. To locate the University and its various components, you can visit www.ualberta.ca and/or see the colour-coded campus map attached at the end of this document, or visit the site http://www.campusmap.ualberta.ca/.

WELCOME AND REGISTRATION

Registration on Friday will be from 1430 to 1845, on the main floor foyer of the Education Centre South building (#81 on the campus map). BBQ Dinner (at 1700) is in the courtyard outside of the Education Centre North cafeteria. The opening session (1845) and the first plenary (1930) will be in the Education Centre. The reception (2030) will take place in the 4th Floor Education Centre North lounge.

You will also be able to register from 0800 to 0900 on Saturday on the main floor foyer of the Education Centre South building (#81 on the campus map).

HOW TO GET THERE

Driving.

There are multiple routes to the University of Alberta from the north, south, east and west. The Education Centre is located on the main campus on the south side of the river and in the north-east corner of the 87 Avenue and 114 Street intersection.

From the South: Take Gateway Boulevard (103 Street) to the north; turn left on Whyte Avenue (82 Avenue); turn right on 112 Street; turn left on 87 Avenue. The Education Centre will be on your right between 113th and 114th Street.

From the North: Take Groat Road going south; after crossing the river turn left on 87 Avenue. The Education Centre will be on your left side at 114 Street **OR** take Wayne Gretzky Drive (75 Street) to the south; cross the river and continue to Whyte Avenue (82 Avenue); turn right on Whyte Avenue (82 Avenue); turn right on 112 Street; turn left on 87 Avenue. The Education Centre will be on your right side between 113 Street and 114 Street.

From the West: Take Whitemud Drive to the east; right after crossing the river turn left on Fox Drive; on the signal turn left on Belgravia Road; turn left onto 114 Street; turn right on 87 Avenue. The Education Centre will be on your left side.

By train.

From the South or from the North. The Edmonton Light Rail Transit (LRT) System connects the north and the south of the city and can be used to get to the University of Alberta. Getting off at the University Station, will let you out just to the north of the Education Centre North (#80 on the campus map). The fare is $3.20 and includes transfers up to 90 minutes from the validation time.

Flying.

From the Edmonton International Airport.

Bus route 747 travels directly (no stops en route) from the airport to the Century Park LRT Station. The fare is $5 one way (no transfer to regular buses or LRT service). From Century Park Station you can take the regular LRT service to get to the University of Alberta (see "How to get there by train").

Shuttle service is available from the airport to the University of Alberta Lister Centre (#101 on the campus map). It costs $18 one way or $30 round trip for an adult. Trips to the airport must be booked online or by phone (780-465-8515). More information about the shuttle service can be found at http://edmontonskyshuttle.com/.

The airport is serviced by a few taxi companies that provide taxi service from the airport to the University of Alberta Lister Centre (#101 on the campus map). It costs $55 one way. More information about taxi services can be found at http://flyeia.com/coming-and-going/taxis-and-limos.

24-7 Taxi Line: 780 442 4444
Airport Taxi Service: 780 890 7070
Co-op Taxi Line: 780 425 2525

PARKING

If you are travelling to the University of Alberta by car each day, the closest parking is at the Education Car Park located on 114 Street just north of 87 Avenue (#78 on the campus map). The fee is $15 per day on weekdays; $5 per day on weekends; and $5 after 4:30 pm on weekdays and weekends, payable on entry in cash or credit cards.

ACCOMMODATION

We have booked a block of rooms at the University of Alberta Lister Centre (#101 on the campus map), which is only a 10-minute walk to the Education Centre South. Queen guest rooms ($109), double guest rooms ($109), queen with sofa bed guest rooms ($109), single private rooms ($69), traditional single rooms ($49) and traditional twin rooms ($59) are available for participants of the conference. More information about the accommodations can be found at:

http://www.asinfo.ualberta.ca/ConferenceServices/ShortTermAccommodation.aspx.

Traditional Rooms

Single and twin rooms are available; shared washrooms are centrally located on each floor. Linen and towel services are provided. Each floor includes a lounge with a telephone and cable television, a kitchen and coin-operated laundry. Note that parking charges are extra and may be arranged upon check in.

Private Rooms

Accommodation is provided in single occupancy (one single bed). Nightly rates include high speed internet access. Guests are required to provide their own computer and ethernet cable. Rooms offer private washrooms, a work desk, linen and towel services. Each floor includes a lounge with cable television, telephone service with free local calls, a kitchen, and coin-operated laundry. Note that parking charges are extra and may be arranged upon check in.

Guest Rooms

Nightly rates include overnight parking, Tim Horton's medium coffee or tea and breakfast pastry, and high speed internet access. Guests are required to provide their own computer and ethernet cable. Rates are based on single or double occupancy. Extra people per room are charged at $15 per person per night. Guest rooms offer televisions with cable service, telephones with free local calls, hair dryers, clock radios, as well as daily housekeeping service.

Booking your Accommodation

You can contact the Guest Services front desk at 780-492-6056 to reserve an accommodation. Please identify the group name CMESG/GCEDM when making your reservation.

Check-in and Check-out

You must check-in at the Guest Services front desk on Lister Centre (#101 on the campus map). Check-in on arrival is at 1600 and check-out is at 1100.

HOTEL

Although no rooms have been booked for CMESG, Campus Tower Suite Hotel is within 5 minutes walking distance of Education Centre South. Information about the hotel can be found at http://www.campustower.com.

MEALS

All lunches and dinners will be taken together as a group. Dinner on Saturday (on your own) will give you the opportunity to explore some of the unique cuisines available in Edmonton.

EXCURSIONS

The excursion will take place on Sunday June 1st. We will briefly tour the architectural highlights of downtown Edmonton before arriving at Fort Edmonton Park, which is located on the south bank of the North Saskatchewan River. Fort Edmonton Park will allow you to go back in time and visit Edmonton as it was between 1846 and 1929, experiencing the fur trade era, the settlement era, the municipal era, and the metropolitan era. After exploring the site, we will have dinner at the rustic Egge's Barn. For more information, see http://www.fortedmontonpark.ca

EMERGENCY

In a case of emergency during the meeting, you can contact Florence Glanfield at 780 995 8139 or 780-492-0743. You can also phone or text Lynn McGarvey (lynn.mcgarvey@ualberta.ca) at 780-718-1702.The University also has Protective Services available at all times at 780-492-5050. During regular working hours, you may also contact the Department of Secondary Education (780-492-3674).

POST-CONFERENCE ACTIVITIES

When in Alberta one shouldn't miss the opportunity to visit the beautiful Rocky Mountains. Jasper National Park, the largest and most northerly of Canada's Rocky Mountain parks is a four hour drive from Edmonton. People interested in spending two nights in Jasper (June 3 - 5) can contact Elaine Simmt (esimmt@ualberta.ca) for more information.

FEES

The conference fee ($210 if registration is received by May 2 and full payment by May 9, $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 dinner at Fort Edmonton Park, and other local costs.

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

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

MEMBERSHIP AND REGISTRATION FORMS

The membership renewal, conference registration, and accompanying persons' registration forms are available online (except for the payment) on the CMESG website: http://www.cmesg.ca. If you encounter issues using the online registration form, please contact Chantal Buteau: cbuteau@brocku.ca.

ASSISTANCE TO GRADUATE STUDENTS

CMESG has limited funds available to support full-time graduate students who wish to attend our annual meeting and who are not able to do so without additional financial support. For details and an application form please see our website: http://www.cmesg.ca.

MATH GALLERY

All CMESG members are invited to present their work at the ***CMESG Math Gallery***. Please indicate your intended participation on the registration form.

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**, who 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 Elaine Simmt at esimmt@ualberta.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: Dave Hewitt *University of Birmingham, U.K.*	***The economic use of time and effort in the teaching and learning of mathematics***

Many children spend four years of their life before entering formal education and what they achieve during this time is impressive. In contrast I sometimes feel that relatively little is achieved in the five years of secondary mathematics schooling. How might we try to access in mathematics lessons the impressive learning that all students exhibited as young children? We can never know what might happen during any given mathematics lesson but what are the guiding principles which lay behind the choices we make as teachers? l will take a broad brush to look at some principles which have guided me in my wish to reduce the wastage of students' time and effort in mathematics classrooms.

Lecture II: Nilima Nigam *Simon Fraser University*	***Is there really good mathematics in industry? And do we want our students to know this?***

There is a considerable amount of hype surrounding the importance of mathematics and mathematical problem-solving to industry and society at large. We have this vision of mathematically-trained students marching into a crowd of perplexed scientists, scribbling some important things, and resolving knotty problems.

In this talk, I describe some examples of mathematical problem-solving as applied to real problems from industry and the non-profit sectors.

Through these anecdotes, I seek to examine, critically, whether the problem-solving skills valued by industry are the same as those valued by mathematicians and educators. Are we teaching students the mathematical concepts industry needs? And is this even desirable or attainable?

I don't have the answers. Indeed, these questions may well be unanswerable. I believe, however, that they warrant discussion.

ELDER TALK

Tom Kieren	***Mathematics knowing and inter-action***

In this presentation I will discuss a model of mathematics knowing originally generated by Elaine Simmt and elaborated by her and me most recently in a 2009 paper in Complexity and Education. I will use this model to highlight the various ways inter-action affects mathematics knowing and also discuss the roles of three "ethics" in this inter-action. I will then discuss just how this model might relate to mathematics knowing in action in mathematics classrooms in general and will give examples of how it can be used to observe the effects of inter-action on knowing using examples taken from my teaching of and observation of a grade 4 class learning about fractional numbers.

PANEL

Lynn McGarvey, University of Alberta ***David Reid, Acadia University / University of Bremen*** ***Annie Savard, McGill University*** ***Dave Wagner, University of New Brunswick***	***What have we not been hearing about the PISA?***

Working Group A *Leaders: Mary Stordy, Susan Oesterle, and Frederic Gourdeau*	***Mathematical Habits of Mind***

In 1996, Cuoco, Goldenberg and Mark raised a question that continues to be appropriate today: "Given the uncertain needs of the next generation of high school graduates, how do we decide what mathematics to teach?" In their article, they go on to question the appropriateness of a content driven curriculum, proposing instead that it be organised around "Mathematical Habits of Mind".

> A curriculum organised around habits of mind tries to close the gap between what the users and makers of mathematics do and what they say. ...[It] lets students in on the process of creating, inventing, conjecturing and experimenting ... It is a curriculum that encourages false starts, calculations, experiments, and special cases. (p. 376)

Since that time, many others have tried to define and elaborate what is encompassed by the notion of "Mathematical Habits of Mind" (see Lim & Selden, 2009). Broadly speaking, they can be thought of as productive approaches and ways of looking at problems (and the world) that are typical of practising mathematicians--potentially including Mason et al.'s (2010) "natural powers and processes": specializing and generalizing, conjecturing and convincing, imagining and expressing, stressing and ignoring, classifying and caracterizing.

Over the last decade, advisory committee recommendations (US-based) seem to be increasingly emphasising the importance of preparing students to approach problems and look at the world the way that mathematicians do. This is captured in the NCTM Principles and Standards (2000), which advocates students acquiring "habits of persistence and curiosity" and observes that "[p]eople who reason and think analytically tend to note patterns, structure, or regularities in both real-world and mathematical situations." In Adding it Up (2001), Kilpatrick, Swafford and Findell describe a "productive mathematical disposition" as "a habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy". These ideas have begun to find their way into the Canadian mathematics curriculum: they are implicit in the WNCP K - 12 curriculum and have now become explicit in the new Draft BC Mathematics K - 9 curriculum, released late in 2013, which describes its major change as "a focus on developing mathematical habits of mind and encouraging students to wonder how mathematicians think and work".

This has implications for how mathematics will be taught in schools and will impact how we prepare teachers. The Conference Board of the Mathematical Sciences (2012), clearly addresses this, recommending: "All courses and professional development experiences for mathematics

teachers should develop the habits of mind of a mathematical thinker and problem-solver, such as reasoning and explaining, modeling, seeing structure, and generalizing" (p. 19).

Mason et al. (2010) stress that "it is vital to educate one's awareness by engaging oneself in mathematical tasks which bring important mathematical awarenesses to the surface, so that they can inform future action" (p. xii). In this working group, we plan to take this advice to heart as we seek to come to a collective understanding on what might constitute mathematical habits of mind and to consider how we might foster/nurture these in our pre-service teachers.

References and Suggested Readings

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2. BC Ministry of Education. (2013). Transforming Curriculum and Assessment--Mathematics. Retrieved from https://curriculum.gov.bc.ca/curriculum/Mathematics

3. The Conference Board of the Mathematical Sciences. (2012). The mathematical education of teachers II. Retrieved from http://www.cbmsweb.org/

4. 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.

5. Cuoco, A., Goldenberg, E. P., & Mark, J. (2010). Contemporary curriculum issues: Organizing a curriculum around mathematical habits of mind. Mathematics Teacher, 103(9), 682-688. (can be found at: http://www2.edc.org/cme/showcase/HabitsOfMind.pdf)

6. Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). Adding+ it up: Helping children learn mathematics. National Academies Press.

7. King, K. (2013). Mathematical Habits of Mind. Retrieved from horizonsaftermath.blogspot.ca

8. Lim, K., & Selden, A. (2009). Mathematical Habits of Mind. In S. L. Swars, D. W. Stinson, & S. Lemons-Smith, (Eds.), Proceedings of the 31st annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (Vol. 5, pp. 1576-1583). Atlanta, GA:Georgia State University.

9. Mason, J., Burton, L., & Stacey, K. (2010). Thinking Mathematically (2nd ed.). Pearson: London.

10. Mason, J., & Spence, M. (1999). Beyond mere knowledge of mathematics: The importance of knowing-to act in the moment. Educational Studies in Mathematics, 38, 135-161.

11. National Council for Teachers of Mathematics (NCTM) (2000): 2000 Principles and Standards for School Mathematics. NCTM, Virginia.

Working Group B *Leaders: Nadia Hardy and Chris Suurtamm*	***Formative assessment in mathematics: Developing understandings, sharing practice, and confronting dilemmas***

Formative assessment has been shown to be a strong lever in improving student achievement, particularly for students who are struggling (Black & Wiliam, 1998). Yet, interpretations of what formative assessment is vary greatly (Shepard, 2005). In this working group we will collectively explore the meanings and understandings of formative assessment. Through group sharing and classroom and research artifacts (video, audio, ipad portfolios, transcripts, blogs) we will consider a range of formative assessment practices used from Kindergarten to graduate school to elicit students' mathematical thinking. Issues and dilemmas that arise in the use of formative assessment will be discussed and frameworks for considering dilemmas in practice will be examined for their usefulness in supporting teachers (Suurtamm & Koch, in press; Windschitl, 2002). Prospective participants are encouraged to bring examples of formative assessment practices and issues.

Tentatively the working group will be guided by the following questions:

1. What meanings are given to formative assessment?
2. In what ways do formative assessment practices support student learning?
3. What does formative assessment look like? With different students? At different grades?
4. What dilemmas do teachers face in incorporating formative assessment?
5. How can formative assessment be supported?

While these questions are suggested to guide the group, our goal is to facilitate discussion and meaningful work that best address the interests and needs of participants.

References

Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. Phi Delta Kappan, 80(2), p. 139-148.

Shepard, L. A. (2005, October). Formative assessment: Caveat emptor. Paper presented at the ETS Invitational Conference 2005, New York.

Suurtamm, C., & Koch, M. (in press). Navigating dilemmas: Mathematics teachers' experiences with transforming assessment practices. Educational Assessment, Evaluation and Accountability.

Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. Review of Educational Research, 72(2), 131-175.

Working Group C *Leaders: Richard Barwell and JF Maheux*	***Texting mathematics***

What does it mean to read and write mathematics? How do we do we read and write mathematics? What can we say about how it is done? We understand 'reading' and 'writing' broadly, to include not only the interpretation and production of mathematical texts as conventionally understood (historic or contemporary, in textbooks or students' work, etc.), but also the ephemeral texts of spoken words and gestures, the visual texts of moving or still images and, ultimately, any of the semiotic 'traces' we come across in doing mathematics.

Language and mathematics precede us—they are there before we are born. To speak we must appropriate the words of others and, therefore, we come to read and write mathematics through the words of others. Moreover, as David Wheeler observed in the 1983 Mathematics and language working group report, mathematical language has its own history. This means that all mathematical texts are related in some way, through time and space. The geometry of today, for example, has traces of Euclid and of Descartes. And in any particular mathematics classroom, the unfolding conversation over time carries references, quotations, echoes of earlier discussions, both within the class and within mathematics. Our aim for this working group, then, is to explore links and connections that can be discerned in the texts that arise in doing mathematics.

We will offer participants various tasks to help us work on these issues. These tasks will include examination of various mathematical texts, both historical and contemporary. We also propose to create our own mathematical texts, through working on selected mathematics problems. Moreover, we would like to film our work on these problems, to create a record (a text) of our Working group conversation, our reading and writing of mathematics. We can then examine parts of this record to observe our own reading and writing of mathematics and the connections we make between the texts that we use (so creating a new text).

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Working Group D *Leaders: France Caron, Dave Lidstone, Miroslav Lovric*	***Complex Dynamical Systems***

> "Complex systems are systems that comprise many interacting parts with the ability to generate a new quality of collective behavior through self-organization, e.g. the spontaneous formation of temporal, spatial or functional structures. […] This recognition, that the collective behavior of the whole system cannot be simply inferred from the understanding of the behavior of the individual components, has led to many new concepts and sophisticated mathematical and modeling tools for application to many scientific, engineering, and societal issues that can be adequately described only in terms of complexity and complex systems." (Meyers, 2011)

What new insight has mathematics brought to our understanding of the complex and fragile world in which we live? What new concepts and new ways of modelling have emerged with the mathematical study of complexity? How much does this field of mathematics relate to the mathematics that is typically taught and learned? Can it be regarded as a logical continuation, an important shift or an interesting enrichment? Could the mathematics curriculum develop a tighter connection with the analysis of complex systems and their dynamics? And if so, at what level? Building on what? Moving from what? Using what?

> "We believe that with time and effort, innovations in computational representations will make democratic access to systems dynamics possible." (Kaput and Roschelle, 1999; republished in 2013).

Dynamic modelling and simulation tools such as Stella and StarLogo have been around for quite some time to study the evolution of complex systems, they are regularly updated with more features and friendlier interface, yet they have had relatively low penetration in schools. Could these tools be of use in today's math curricula? Could they help reflect on new directions for the curriculum with respect to modeling and problem solving? Should we turn to other tools and approaches to grasp the notion of complexity in the mathematics of change, and get a deeper understanding of what equilibrium really mean? Or could we build on what we already do?

Through learning activities, simulations and games, the participants of this working group will explore some of the concepts and approaches associated with the mathematics of dynamical complex systems and analyse their potential for inclusion in secondary and postsecondary mathematics.

References:

Bar-Yam, Y. (1997) Dynamics of Complex Systems, Perseus, Reading, MA. http://necsi.edu/publications/dcs/

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Working Group E *Leaders: Carloine Lajoie and Rina Zazkis*	***Role-playing and script-writing in Mathematics Education: Practice and Research***

Role-play involves staging a problematic situation with characters taking roles. It may be used to fulfill various objectives such as therapeutic objectives, personal and professional training objectives, or may be used as a pedagogical method. Despite various reports on the benefits of this method, its use in Mathematics Education is underdevelopment. As such, the **goal of our working group** is to examine the affordance of role-playing in mathematics education in various settings. We will also consider the affordances of script-writing, which we define as imagined (rather than enacted) role playing.

To achieve this goal the participants will

- actively examine various scenarios in which role play is enacted or imagined,
- analyze various plays composed by students, and
- design scenarios or prompts for settings of their choice

Since the beginning of years 2000, role-playing has been used by Caroline Lajoie and her colleagues in methods courses for prospective elementary school teachers at UQAM. In their setting, students take the part of a teacher while others act as students, and they improvise around a mathematical task, a student's question or production, the use of teaching material, and so on. Also, more recently, role-play has been used as an approach to research on mathematics teacher education.

Script-writing was used by Rina Zazkis and her colleagues as "lesson plays", in which prospective teachers designed an imaginary interaction between a teacher and her students. It was also used as "proof scripts", where undergraduate students developed interaction around 'problematics" in a particular given proof.

We will provide a VERY SHORT synopsis of the past pedagogical implementation and research, with the intention to extend the future scope of applicability of role-playing and script-writing to additional settings and populations.

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TOPIC SESSIONS

Topic Session A *Lisa Lunney Borden*	***Mawkinumasultinej! Let's learn together! Developing culturally-based inquiry projects in Mi'kmaw communities***

Mi'kmaw schools in Nova Scotia are striving to meet curriculum expectations while maintaining a strong sense of Mi'kmaw cultural identity. One example of such cultural integration is in the area of mathematics. Building on the highly successful Show Me Your Math (SMYM) program which invites students to investigate the mathematics in their own community context, in recent years I have received funding to develop community-based inquiry units drawing from student projects and conversations with elders. These units explore the mathematics involved in birch bark biting, paddle making, basket making, quill work, eel fishing, snowshoe making and more. In this topic session I will share stories that have emerged from the process of developing these units in communities and share insights I have gained from this work. I will also share how teachers and students are responding to these learning opportunities and how this is actively decolonizing mathematics education for Mi'kmaw learners.

Topic Session B *Olive Chapman*	***Mathematical Problem-Solving Knowledge for Teaching***

Mathematical problem solving is central to doing and learning mathematics. Therefore, it should also be a key component of mathematics teachers' knowledge. Teachers need to hold Mathematical Problem-Solving Knowledge for Teaching [MPSKT]. What ought to be included in this knowledge? What should teachers know in order to teach for problem-solving proficiency? What is problem-solving proficiency? What knowledge should teachers hold to helpstudents become proficient in mathematical problem solving and to understand it as a way of thinking about, doing and learning mathematics? These and other related questions are discussed from a theoretical perspective and a practice-based perspective. The latter is based on a study of secondary school mathematics teachers' thinking about and teaching with contextual problems. The study aimed at understanding and conceptualizing MPSKT based on the knowledge the teachers held and used, how they used it, and its impact on students' engagement with contextual problems.

Mathematics teacher educators also need to hold MPSKT. What is the nature of this knowledge?

Topic Session C *Lucie DeBlois*	***Interactions in classroom: tensions between understanding and learning difficulties in mathematics***

Our research on interpretation of pupil's cognitive activities in mathematics (DeBlois, 2003; 2014) and on teacher's sensibility about pupil's errors (DeBlois, 2006, 2009) showed emergence of tensions in a class (DeBlois, 2014 in press). We hypothesize that variety of pupil's difficulties emerge from interactions in class (DeBlois, 2008, 2012). We have choice to enter in this study by the way of behaviour of pupils: anxiety, agitation and evitment of task. In this way, we observe how help to learn problem solving rather help pupil to learn problem solving conduct to develop habits who «algorithmize» or «socialize» knowledge. Tension between teaching time and learning time could explain creation of association rather relationship between characteristic of notions to teach and to learn. Examples will be presented to surround roles played for knowing sense and value attribute to mathematics knowledge.

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NEW PHD SESSIONS

Alayne Armstrong	***Problem Posing as Storyline***

This dissertation investigates the problem posing patterns that emerge as four small groups of Grade 8 students work collectively on a mathematics task in a classroom setting. The concept of author/ity is used to highlight human agency in mathematics. Small groups, as learning systems, are being considered to be "authors" of their discourse, and the improvisational nature of authoring is discussed. A parallel is drawn between the storyline of a literary work and the storyline that emerges when a group poses problems in order to work its way through a mathematical task. A method of data analysis is introduced that "blurs" the data in order to capture group discourse patterns that emerge over time – transcripts are color-coded and then shrunk to create tapestries that provide visual evidence of collective problem posing patterns. Findings suggest the posing of problems by a collective is a process that is emergent, creative and generative.

Claudia Corriveau	***An ethnomethodological perspective on teachers' ways of doing mathematics to explore the transition from secondary to postsecondary level***

In my thesis, I studied the transition between secondary and postsecondary level through teachers' « ways of doing mathematics ». These ways of doing mathematics, which characterize a certain mathematical culture at each level, are constituted in the implicit of teachers' action. Two theoretical foundations allowed me to explore the object "ways of doing mathematics". First, it was developed through a cultural theory (Hall, 1959) to take into account the context of transition in which it is studied. Secondly, ethnomethodology (Garfinkel, 1967) provided relevant elements to better understand, on a theoretical level, how they are constituted in teachers' everyday practice. A group of six participants (three secondary teachers and three post-secondary teachers) were invited to join a collaborative research project. Three themes emerged from the analysis: the use of symbolism, the use of contexts and the work with functions. The first part of my analytical work highlighted a territory of particular ways of doing at each level (for each theme). As a second part of the analysis, distinctions between both levels and transitional issues were identified. Finally, in the discussions between the teachers and the researcher, harmonization trajectories between ways of doing mathematics at each level were pointed out and analyzed in order to understand how this harmonization was constituted within the group.

Lissa D'Amour	***Addressing Anxiety: From Demanding Performance to Giving Audience***

Taking seriously the world in a grain of sand, a two-year inquiry with one mathematics learner becomes hermeneutic window into a theoretical exploration of learning. Psychoanalytic theory and neuroscience inform a complexivist understanding of Cartesian, mathematics, and narcissistic anxieties as nested phenomena at the root of systemic pathologies today. These are the symptoms of a hypervigilent society preoccupied by preemptive performative demands to attain to disembodied Platonic ideals. Identifying rigid cover stories as pathology's signature, I study pervasive failings of trust.

Principles of "good enough" and of play—as the articulating space of sense-making between a given, discoverable, and disillusioning world and a world that is made, conceivable, and therefore illusive—ground a theory of learning and a pedagogy of attunement. Here acts of giving audience and bearing witness hold the world's pathologies sufficiently at bay whilst encouraging momentum toward recursively expanding self-authoring into adaptive wellness with world.

George Ekol	***Examining constructs of statistical variability using mobile data points***

Statistical variability is considered by researchers and educators as the very foundation of statistics–without variability, there is no need for statistics. Research studies, however, reveal that while post-secondary students are good at calculating formal measures of variability such as the range, the interquartile range and the standard deviation, many are challenged by what these measures mean. Based on research studies that use dynamic computer–based tools for learning mathematical concepts, I assumed that dynamic mathematics sketches (DMS) support students' understanding of the functional connections among data distribution, the mean and the standard deviation. In my dissertation, I describe the design of the DMS and report on the data collected from a small group of students in an introductory statistics course. The findings are interpreted from a semiotic mediation perspective as well as theories about students' reasoning with numerical data. I will highlight theoretical and methodological contributions of my study to the teaching of post-secondary introductory statistics.

Pamela Anne Hagen	***Listening to Students: A Study Of Elementary Students' Engagement In Mathematics Through The Lens of Imaginative Education***

This study investigated the problem of student engagement in elementary mathematics through the particular theoretical framework of imaginative education (IE) (Egan, 1997, 2005). For this study, six intermediate-aged elementary students were tracked through a geometry unit framed with the binary opposites of vision and blindness. The study used qualitative instrumental case study methods gathering rich descriptive data focused on bringing out the students' perspective of their experience.

Results indicate that the students' demonstrated positive engagement with mathematics and that the IE theory, which utilized the students' imaginations and affective responses, allowed multiple access points to the mathematical concepts. Three conclusions of the study were that the students expanded their mathematical awareness through making a variety of connections, they were able to develop self-confidence in their learning of mathematics by using emotions and imagination, and they were able to use cognitive tools, particularly a sense of wonder, to engage with mathematics.

Jennifer Hall	***Societal Views of Mathematics and Mathematicians and their Influence on Elementary Students***

This study investigated elementary students' views of and experiences with mathematics and mathematicians, and the ways that their views may be influenced by popular media representations, parents' views, and teachers' views. Framed by a social constructivist and feminist epistemological stance, the study employed a multi-method framework comprised of questionnaires, drawings of mathematicians, and focus group interviews with Grade 4 and 8 students; an analysis of children's media; and interviews with parents and teachers. While the participants' relationships with mathematics were generally positive, the manner in which they conceptualized mathematics tended to lack breadth. Moreover, media portrayals of mathematicians often perpetuated stereotypes. Despite their awareness of these stereotypes, most participants lacked alternative representations to challenge these views. Indeed, the lack of exposure to a variety of representations of both mathematics and mathematicians contributed to the participants' reliance on views that were often narrow and stereotypical.

Limin Jao	***Perceptions, Pedagogies, and Practices: Teacher Perspectives of Student Engagement in Grade 9 Applied Mathematics Classrooms***

My study investigated the teaching practices that three Grade 9 Applied Mathematics teachers used to increase student engagement and enhance student learning. Qualitative data were collected in the form of teacher interviews, classroom observations and teacher journals. Findings showed that these teachers considered aspects of both social (e.g., creating a classroom community and developing a teacher-student relationship) and academic (e.g., using technology, manipulatives, group work and student-centered activities) domains of student engagement in their teaching, but to varying degrees and with different emphases. Implications from this study suggest that Grade 9 Applied Mathematics teachers should consider a variety of factors for social and academic engagement as well as characteristics of their early adolescent learners to increase student engagement in the class. Additionally, teachers will favour approaches that parallel their personality and values and efforts in one factor may support other factors of student engagement.

Richelle Marynowski	***From Frustration to Understanding: An Inquiry into Secondary Mathematics Teachers' Experiences with Government Mandated Examinations***

Government mandated examinations (GMEs) are a visible part of the education system in Alberta, Canada, and throughout the world. Understanding how teachers experience teaching within the context can provide insight into how teachers negotiate demands on their work. The purpose of this study was to develop an understanding of secondary mathematics teachers' experiences in a context of GMEs. Having had my own experiences teaching mathematics courses where students wrote a GME, I had my own understandings of GMEs that were inconsistent with what I was hearing from colleagues. Using Gadamerian philosophical hermeneutics, the experiences of three secondary mathematics teachers were explored. In this presentation, specific teacher experiences will be presented alongside what those experiences and the language used in the telling of the experiences can tell us about teacher perceptions of and relationships with GME's.

Nenad Radakovic	***Towards the Pedagogy of Risk: Teaching and Learning Risk in the Context of Secondary Mathematics***

A qualitative case study was presented in order to explore an inquiry-based learning approach to teaching risk in two different grade 11 mathematics classes in an urban centre in Canada – an all-boys independent school (23 boys) and a publicly funded religious school (19 girls and 4 boys). The students participated in two activities with the purpose of determining the empirical probability and the impact of a nuclear power plant accident based on the authentic data. The study confirms the Levinson et al. (2012) pedagogic model of risk and expands on it by suggesting that pedagogy of risk should include five components: 1) knowledge, beliefs, and values, 2) judgment of impact, 3) judgment of probability, 4) representations, and 5) estimation of risk. The study implies that meaningful instruction about risk should go beyond mathematical representations and reasoning and include other components of the pedagogy of risk.

Dov Zazkis	***Calculus Students' Representation Use in Group-Work and Individual Settings***

The study of student representation use, specifically the distinction between analytic and visual representations, has driven a long line of mathematics education research. This literature can be partitioned into two bodies of work, one that is primarily cognitive and one that is primarily social. In spite of the large overlap in the results and foci of these two bodies of work they have tended to not inform one another. I bridge these two bodies of work by creating and implementing an analysis tool, referred to as the VAP-model, which can be used within both group- work and individual interview settings. This model facilitates the analysis of calculus students' transition between representations during problem-solving and how these transitions fuel students' mathematical advancement.