CANADIAN MATHEMATICS EDUCATION STUDY GROUP

44TH ANNUAL MEETING

A VIRTUAL EVENT

JUNE 11TH TO JUNE 13TH , 2021

ANNOUNCEMENT AND PROGRAM

We are pleased to bring our annual CMESG meeting to our community as a virtual event this year. Though we will miss gathering in person, we look forward to gathering virtually. Our program will be somewhat scaled back this year to accommodate our virtual format but we are excited to bring a program that contains a plenary address, five working groups, 12 new PhD presentations, and some social time of course.

This year's meeting will include special joint sessions with CMS (Canadian Mathematical Society) and GDM (Groupe de didactique des mathématiques du Québec). All CMESG members are welcome to attend the CMS conference (https://summer21.cms.math.ca/) from June 7-11, 2021, as long as their CMESG membership is up to date. Additionally, we will be co-hosting a panel on June 7, 2021 at the CMS conference from 2:00-4:00 pm EST that focuses on Data Literacy in light of world events of the past year. A description of this panel is contained later in this program. GDM is free for anyone to attend (https://www.gdm.quebec/colloque) and we will welcome all GDM attendees to join our opening plenary on June 11, 2021. We encourage all members to explore these options to broaden their spring conference experience. We are grateful for these partnerships.

Welcome and Registration

HOW WE WILL MEET

All sessions will be held using Zoom. We encourage participants to ensure they have the most recent updates of the Zoom client on their computers to allow participants to be able to move themselves in and out of break out rooms. Check out Zoom support to upgrade: https://support.zoom.us/hc/en-us/articles/201362233-Upgrade-update-to-the-latest-version.

Some Zoom tips:

- Check your technology before the conference and make sure everything works;
- Keep your camera on if you can as this helps to make our interactions more personal;
- Think about your room lighting - can we see you well? If not, you might put a lamp in front of you to light up your beautiful face;
- When not speaking, keep your mic muted to avoid interruptions;
- Use the Zoom tools to engage: send messages and questions in the chat box, use the reactions to raise your hand, give applause, or a smiley face;
- **Please do not share the link with anyone. We will send the links to all registered participants and ask that they not share them or post them. This will help to prevent unwanted guests.**

If you are new to zoom, we will have folks who can help you to become comfortable with it in each working group.

Social Time

Our meals and social times together are one of the things we love about CMESG. We use these times to catch up with old friends and make new ones. While we cannot dine together in person, we will keep the main zoom open during lunch breaks, with breakout rooms created, so that people might catch up during this time or jump in a break out room for an ad hoc session. We have also planned some end of the day social time on Friday and Saturday. Each night will have a special theme.

Friday evening's theme will focus on living local, eating local, drinking local. We invite each CMESG participant to bring a local snack and a local beverage to enjoy. We will have some shared space to allow you to tell us about the snack or beverage and maybe link to a website where others can learn more about your local products and maybe even order something. Have a favourite local craft beer or cider? Maybe a favourite local wine? Tell us about them! have a favourite local cuisine, bakery, produce supplier? Share that with us! In these tough times for many of our local small businesses, let's take this chance to celebrate the food and beverages we love and invite others to love them too.

Saturday night will focus on having fun and making friends in virtual worlds. We will share more details as the day approaches but we are planning an interactive evening of games, puzzles, and social spaces for conversations. Have you ever wanted to live as an avatar? This might be your night! Stay tuned for more details.

Fees

There is no fee for the meeting but memberships must be up to date. According to the constitution, CMESG membership runs from the beginning of one meeting to the beginning of the next. However, since the 2020 meeting was not held face-to-face as usual, this resulted in several people paying their membership fees after the annual meeting (at different times during the year).

If you paid your membership fees in 2020 (regardless of the time of year), those fees were associated with your 2020-2021 membership. **If you wish to attend the 2021 annual meeting, we ask that you pay your membership fees in 2021.**

Don't remember when (or if) you paid your membership fees in 2021? If you did, you have received an email entitled "CMESG Receipt / Reçu pour le GCEDM" from Manon LeBlanc containing your receipt. Still not sure? Send an email to Manon LeBlanc (manon.leblanc@umoncton.ca) and she will check for you.

FRIENDS OF FOR THE LEARNING OF MATHEMATICS [FLM]

All members of CMESG are also members of the FLM publishing association. Please note online sessions will be held for the FLM board as well as an open session for all CMESG members. Please see below:

June 10 10:00-11:30 PDT (or 1:00 – 2:30 EDT) FLM Board of Directors Meeting

June 10 12:00–1:00 PDT (or 3:00 – 4:00 EDT) FLM Q&A (formally Friends of FLM) Everyone Welcome

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 sessions to interact around a particular topic. Normally, there are two **plenary speaker sessions, however this year there will only be one plenary address who** will 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 plenary speaker in a question period. Additionally this year, we will host the **new PhD sessions**, but a bit differently. The New PhDs were invited to produce a video presenting their work. We now invite you to watch these videos before coming to discussion sessions with them. We believe that CMESG is an occasion for them not only to present their work, but also to be able to share discussions about it, so we ask that you **watch the videos in advance** for sessions you plan to attend.

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 zoom room left open during the one hour lunch break so that people might engage in ad hoc discussions in break out rooms. Unfortunately this year, due to the online format, there will not be a gallery walk. .

Finally, many of us will be missing our meals together this year, however, we have planned for social time at the end of each day and we invite you all to use this time as you would our traditional in person meal times. Chat with those you know, chat with those you are getting to know, chat with someone you don't know – the social times are an integral part of the conferring that makes CMESG such a special conference.

PLENARY LECTURES

Lecture I ***Sarah Mayes-Tang*** ***Joint session with CMS/GDM***	***Teaching on Empty: Trauma, Achievement, and What's Next in Our Math Education Community***

PANEL

Panelists TBA *Moderator: Patrick Reynolds* ***Joint Session with CMS to be held on Monday June 7 at the CMS Summer meeting from 14:00-16:00 Eastern.***	

WORKING GROUPS

Working Group A *Joyce Mgombelo, David Reid*	***Learning Theories***

There are many kinds of theories in mathematics education ranging from local theories (of learning a specific topic) to global theories (of cognition). In this working group we are interested in global theories of learning, and how they learn and change. We consider Lakatos' Methodology of Scientific Research Programs as a starting point for our discussions of learning theories and how learning theories learn. We

consider both the hard core of a theory that defines it (its organisation in Maturana & Varela's terminology) and the 'protective belt' that allows a theory to learn (its structure):

It is this protective belt of auxiliary hypotheses which has to bear the brunt of tests and get adjusted and re-adjusted, or even completely replaced, to defend the thus-hardened core. (Lakatos, 1978, p. 48)

Participants may find it interesting to consult the following in advance:

Bikner-Ahsbahs, A., & Prediger, S. (2006). Diversity of theories in mathematics education—How can we deal with it?. *Zentralblatt für Didaktik der Mathematik*, *38*(1), 52-57.

Davis, B. & Francis, K. Discourses on Learning in education https://learningdiscourses.com/learning-discourses/

Lakatos, I. (1978). *The Methodology of Scientific Research Programmes: Ed by John Worrall and Gregory Currie*. Cambridge University Press.

Maturana, H. R., & Varela, F. J. (1987). *The tree of knowledge: The biological roots of human understanding.* New Science Library/Shambhala Publications.

Radford, L. (2008). Connecting theories in mathematics education: Challenges and possibilities. *ZDM*, *40*(2), 317-327.

Working Group B *Richelle Marynowski,* *Jhonel Morvan*	***To test or not to test: Is this the question?***

Tests are a common way of creating data regarding student learning in mathematics from primary school to post secondary. Testing students and teachers in mathematics/numeracy at the provincial/national level has gathered momentum in several jurisdictions, including Ontario and Australia. International tests like the Programme for International Student Assessment (PISA) offer tests that are used to compare countries and provinces. However, in each of these cases what is truly being tested? How are the results of these tests being used? Why are we even using tests anymore? Is there not a better way? This working group will focus on the phenomena of using tests to generate data about student learning and teacher proficiency in mathematics and the potential alternatives. The discussions will take into consideration the contexts of classroom, provincial, national, and international testing. The main questions that will be addressed through differing contexts are: who are the tests designed for? For what purpose? Is that the best way to gather that information? And if not a test - what else?

Suggested readings:

Testing of teachers in Australia: https://teacheredtest.acer.edu.au/

Recasting the Grading of Assignments and Tests to Align with Inquiry-Based Teaching Methods: https://www.tandfonline.com/doi/pdf/10.1080/10511970.2019.1664678

PISA Results: https://www.oecd.org/pisa/publications/pisa-2018-results.htm (all countries)

https://www.oecd.org/pisa/publications/PISA2018_CN_CAN.pdf (Canada)

Ontario Math Proficiency Test
https://www.eqao.com/en/assessments/math-proficiency-test

Teacher math tests don't boost student scores, agency finds
https://www.theglobeandmail.com/canada/article-review-shows-testing-teachers-has-little-impact-on-student-performance/

Education Quality and Accountability Office
Literature Review of the Empirical Evidence on the Connection Between Compulsory Teacher Competency Testing and Student Outcomes
https://www.eqao.com/en/research_data/communication-docs/report-literature-review-teacher-competency-testing.pdf#search=literature%20review

Working Group C *Scosha Merovitz, Mathieu Thibault*	***The rewards and challenges of video in the field of mathematics education: looking back in order to prepare for the future***

In the education literature, we see video being used in multiple ways to support both research and practice (e.g., Duvillard, 2017 ; Expósito, Sánchez-Rivas, Gómez-Calero & Pablo-Romero, 2020 ; Fiorella & Mayer, 2018 ; Poellhuber, 2017). Other works use video specifically to support mathematics learning and teacher professional development (e.g., Borko, Koellner, Jacobs & Seago, 2011, Coles, 2013 ; 2019 ; Jaworski, 1990 ; Sherin & van Es, 2009 ; Towers, 2007 ; van Es, Tunny, Goldsmith & Seago, 2014). Over the past year, many of us have had to move our professional lives online and we have had to redefine our roles as teachers, learners, and researchers. As a consequence, video has played a much larger role than ever before and, in this process of adaptation, we have attempted a variety of new approaches, have learned a lot, and have asked ourselves many questions.

In this working group, we will draw on the participants' knowledge and personal experiences to share ideas, questions, and resources related to video in the teaching and learning of mathematics. Working in both small and large groups, we will build on concerns from past experiences to project into the future and reflect on the role we would like to give to video in research and practice.

This will be an opportunity to consider the rewards and challenges of working with video from the perspective of both research and practice. We will be asking questions such as:

- How have we experimented with video and to what purposes?
- What are some of the challenges we encountered when using video?
- How can we use video to better support our students?

- How can researchers/facilitators use video to support teacher professional development?
- What are some of the particular rewards and challenges related to using video in the field of mathematics (education)?
- Which aspects of video would we like to develop further once we return to in-person teaching?
- What are some of the challenges to consider in terms of using video as a tool for future research and practice?
- What research questions can we ask to help us better understand the rewards and challenges related to the use of video?
- …

Bring your own viewing lenses to Working Group C. We look forward to sharing perspectives!

Working Group D *France Caron, Wes Maciejewski*	***How can we be creative with large classes?***

Large classes are the reality of contemporary post-secondary education. Whether it takes the form of a calculus class of 200 students or a math education or problem solving class with 60 students, every large class undeniably comes with its own set of constraints and challenges. Rather than considering those constraints and challenges as sound reasons not to embark, we will try to look at them as potential levers for creativity. We will also look for opportunities that might be afforded by large classes.

In this working group, we will take large classes as a starting point and address the questions:

1. What types of instruction and learning tasks can be effective in large classes?
2. How and to what extent can technology help?
3. How might large classes enhance the education we offer our students?
4. What viable forms of assessment might support our students' learning?
5. How might large classes challenge and enrich our theories of education/learning/teaching?
6. To what extent does the consideration of online classes change our reply to any of the above questions?
7. We hope to keep a focus on mathematics learning and doing: is there anything unique about mathematical activity in large classes?

All people are welcome to this working group, whether you have taught or only attended large classes. The LARGER the working group, the better!

Suggested readings

Gibbs, G., & Jenkins, A. (2013). *Teaching large classes in higher education: How to maintain quality with reduced resources*. Routledge.

Jungic, V., Kent, D., & Menz, P. (2006). Teaching large math classes: Three instructors, one experience. *International Electronic Journal of Mathematics Education*, *1*(1), 1-15.

Vanpee, D., Godin, V., & Lebrun, M. (2008). Améliorer l'enseignement en grands groupes à la lumière de quelques principes de pédagogie active. *Pédagogie médicale*, *9*(1), 32-41.

Wilsman, A. Teaching Large Classes. Center for Teaching, Vanderbilt University. https://cft.vanderbilt.edu/guides-sub-pages/teaching-large-classes/

Working Group E *Kathy Nolan, Sarah Mathieu-Soucy Tara Taylor*	***Returning to our roots: Exploring collaborative possibilities for research and teaching in mathematics and mathematics education***

CMESG members may recall that the creation of our organization is rooted in a desire for mathematicians and mathematics educators to work together. One goal of this working group is to "return to our roots" and explore these past/present/future collaborations: their challenges and complexities, as well as their successes and outcomes. This will be done first by sharing, and reflecting on, the participants' own experiences with collaboration between mathematicians and mathematics educators, addressing, for instance, the initiation of the collaboration, the nature of the collaboration, emerging issues and concerns as well as results.

A key focus of the working group is to break down barriers and stereotypes, and to build up possible collaborations, between mathematics educators and mathematicians. The working group seeks to reflect on and discuss how collaborations can bring something to both mathematics educators and mathematicians with respect to their own individual (and others') teaching and research, revealing how all perspectives contribute to the collaborations. In the group, we will look at different examples and models (see references) to help us brainstorm goals/outcomes for productive and interesting collaborations.

Working group time will be dedicated to imagining and forming new collaborations, within and beyond the group, and to fostering new sparks of ideas for potential future collaborative projects. The following questions could come up/be addressed/reflected upon in this working group:

- What makes a collaboration between mathematics educators and mathematicians different from a collaboration between mathematics educators and/or between mathematicians?
- What are the differences/similarities between the two communities? Are the two communities mutually exclusive?
- How might barriers or stereotypes between communities be negotiated?

- What are some ideas for how collaborations can be initiated and/or sustained?
- What type of research and/or research topics call for/can be addressed by collaborations between mathematicians and mathematics educators?
- How do mathematicians and mathematics educators coordinate (potentially) different research agendas and cultures, knowledge, interests, purposes, goals, languages, and (internal/external) measures of "success"?
- How do mathematicians and mathematics educators coordinate (potentially) different research agendas and cultures, knowledge, interests, purposes, goals, languages, and (internal/external) measures of "success"?

References

Artigue, M. (1998) Research in Mathematics Education Through the Eyes of Mathematicians. In A. Sierpinska & J. Kilpatrick (eds) *Mathematics Education as a Research Domain: A Search for Identity*. New ICMI Studies Series, vol 4 (pp. 477-489). Springer, Dordrecht

Bass, H. (2005). Mathematics, mathematicians and mathematics education. *Bulletin of the American Mathematical Society, 42*(4), 417–430

Nardi, E. (2008). *Amongst Mathematicians: Teaching and learning mathematics at university level*. USA: Springer

NEW PHD SESSIONS

Marc Husband *Institution: York University* *Supervisor: Lyndon Martin*	***Making Connections to Deepen New Teachers' Understanding of Elementary Mathematics***

Asking teachers to support their students in making mathematical connections is an unreasonable request when teachers themselves have not had opportunities to connect their own understandings. The

outstanding question is how can teachers actually acquire the knowledge and experiences needed to support their students in learning elementary mathematics. My PhD research investigates how newly graduated elementary teachers can deepen their mathematical understanding using tools and strategies similar to those researchers recommend for teaching school students. My case study was conducted in a 10-day Additional Qualification course, where 15 newly graduated teachers worked on elementary mathematics tasks and acted as co-teachers. The video data and student journals were analyzed using Pirie-Kieren's (1994) Theory for the Dynamical Growth of Mathematical Understanding. Tracking participants' learning pathway revealed the connection-making process that deepened their understanding of elementary mathematics.

Judy Larsen *Institution: Simon Fraser University* *Supervisor: Peter Liljedahl*	***Mathematics teaching and social media: An emergent space for resilient professional activity***

Professional activity around mathematics teaching is vital in the improvement of mathematics education at all levels. The rise of social media allows education professionals to congregate through asynchronous communication without prompting, funding or mandate. In this study, I investigate the inner workings and nature of a particular social media collective, the Math Twitter Blogosphere (MTBoS), in which daily activity around mathematics teaching has occurred for almost ten years. To this end, I draw on tenets of complexity thinking(Davis & Simmt, 2003; Davis & Sumara, 2006) and use my awareness as a MTBoS insider to enhance methodological design and analytical depth. My findings illuminate the co-acting influence of social capital and ideational capital on the resilience of ideational artefacts in the collective. As such, the results of this research indicate not only the popular topics within MTBoS, but also, features that drive ongoing and generative professional activity around mathematics teaching.

Colette Lemieux *Institution: University of Calgary* *Supervisor: Olive Chapman*	***The Use of Story-Based Tasks in Post-Secondary Students' Learning of Statistics***

I present my findings on the impact of an intervention, which used stories to explore statistics, on post-secondary students' understanding of statistics and what features of the stories support meaningful learning. A qualitative case study approach was used. The participants were 20 students from a single first-year post-secondary business statistics course in which the intervention was implemented. Data analysis entailed a thematic approach based primarily on open-coding.

The findings suggest that the intervention supported participants development of various types of understanding of topics in statistics and personalization knowledge as part of the process of developing understanding. Further, the findings suggest that the features of the intervention and, in particular, the stories that impact meaningful learning include the prompts embedded within the stories and the nature of the characters introduced in the stories.

Jimmy Avoseh *Institution: Lakehead University* *Supervisor: Ann Kajander*	***Engaging Multiple Representations in Grade Eight: Exploring Mathematics Teachers' Perspectives and Instructional Practices in Canada and Nigeria***

This study was inspired by and utilises representations, one of the mathematical learning processes (NCTM, 2000), which is currently acclaimed as one of the reform-based instructional approaches to teaching and learning algebra. This concurrent mixed methods research project explored elementary in-service teachers' goals for, beliefs about and knowledge of representations, both in Ontario and Lagos. Data were collected through an online survey completed by 91 middle school in-service teachers concurrently with interviews with ten of them. Findings from the survey indicated that teachers from the Lagos subsample had weaker understandings about representations compared with their counterparts from Ontario. In the interviews, participants described to varying degrees their goals for and use of representations as opportunities for students to show connections, relationships, and reasoning, supporting students' confidence in problem-solving, and facilitation and opportunities for questioning and discussion. This research suggests that teachers generally, but particularly in Lagos, need a deeper understanding of representations and need to further develop the specialized mathematics content knowledge related to patterning and algebra. Other findings showed that: planning and sequencing instruction, use of contextual learning tasks, opportunities for students to generate their own representations, linking students' prior knowledge to new situations, and translation among multiple representations were reported as critical to teachers' use of representations. Recommendations are made to create more awareness among teachers, of the value, use and knowledge about representations. These findings would be relevant to school boards, teacher educators, researchers, and professional development providers wishing to improve teachers' use of representations, via enhanced beliefs, and knowledge.

Nicolas Boileau *Institution: University of Michigan* *Supervisor: Patricio Herbst*	***An Investigation of the Relationship Between Two Norms of the Instructional Situation of Geometric Calculations with Algebra in U.S. High School Geometry***

Prior research has demonstrated that norms have considerable influence on human behaviour. It has also demonstrated that, while breaches of norms are sometimes accepted, they are often negatively sanctioned. In my dissertation, I discuss another possible consequence of breaching a norm: that doing so may have individuals (e.g., teachers) abandon their expectations that other norms will be followed. I investigated this possibility by conducting a survey experiment with a national sample of U.S. high school mathematics teachers, focused on two norms of a recurrent instructional situation in U.S. high school geometry called *geometric calculations with algebra*. The results support the hypothesis that breaching a norm of an instructional situation may have teachers abandon their expectation that another norm of that situation will be followed. As such, the results add to a small, but growing body of evidence that mathematics instruction is regulated by sets of interrelated subject-specific norms.

John G. Bosica *Institution: Queen's University* *Supervisor: Jamie S. Pyper*	***Mixed Methods Study on Mathematics Anxiety, Mathematics Teacher Efficacy, and Mathematics Teaching Anxiety on Elementary Preservice Teachers in Ontario.***

Mathematics anxiety and mathematics teacher efficacy are constructs commonly measured in preservice elementary school teachers, but mathematics teaching anxiety is relatively new. Mathematics teaching anxiety separates the anxiety experienced when *doing* mathematics from the anxiety when *teaching* mathematics. This mixed methods study examined the relationship between mathematics anxiety, mathematics teaching anxiety, and mathematics teacher efficacy in preservice elementary school teachers in Ontario. Questionnaire data was gathered from 185 participants, 16 of whom were also interviewed. Results indicate that mathematics teaching anxiety is significantly correlated to mathematics teacher efficacy and mathematics anxiety, but there was no correlation between mathematics anxiety and mathematics teacher efficacy. Furthermore, interview and short answer responses showed that those who were mathematically anxious were aware of their anxieties and developed methods of maintaining effective teaching practices. These results support using mathematics *teaching* anxiety as a measure for identifying preservice teachers in need of help teaching mathematics.

Laura Broley *Institution: Concordia University* *Supervisor: Nadia Hardy et Ildiko Pelczer*	***The development of (non-)mathematical practices through paths of activities and students' positioning: The case of Real Analysis***

Research has documented how the activities proposed in Calculus courses can enable and encourage students to develop "non-mathematical practices." More specifically, these studies have shown that students can obtain good passing grades by learning highly routinized techniques for a limited collection of task types, with little to no understanding of how to mathematically explain the techniques. My doctoral work aimed to explore what happens as students progress to more advanced courses in Analysis. The study I conducted included an analysis of activities typically proposed in one first Real Analysis course and task-based interviews with fifteen students after they passed the course. Qualitative analyses revealed that students' practices could be (non-)mathematical in different ways and to varying degrees. Moreover, this could be linked not only to the kinds of activities proposed throughout the course, but also to the characteristically different ways in which students may have interacted with those activities.

Alexandre Cavalcante *Institution : University McGill* *Supervisor: Annie Savard*	***The financial numeracy afforded in secondary mathematics: A study on the textbooks, perceptions and practices of teachers in Quebec, Canada***

In this research, I investigated the unique role of mathematics in the field of financial education through the concept of financial numeracy. I used mixed methods to analyze tasks from 40 textbooks, the perceptions of 35 teachers in focus groups, and the practices enacted by six teachers when they implemented financial numeracy lessons. The results showed a diverse range of financial numeracy approaches. In the textbook collections, financial numeracy tasks spammed from short word problems that emphasized the explicit mathematical content to open-ended tasks that incorporated students' personal perspectives into the justification of the problems. In the focus groups, the teachers' perceptions revealed the need for clear curriculum connections and pedagogical support. Finally, the classroom data revealed four teaching practices enacted by the teachers: emphasizing procedural fluency, using technology to interpret mathematical results, sharing their personal experiences, and providing practical advice on financial matters. The results of this research contribute to advancing this emerging field of financial education by constructing one coherent framework of financial numeracy. It research provides

insights to what teachers can afford to do based on their own perspectives and the institutional affordances of the school system.

Christopher Charles *Institution: University of Alberta* *Supervisor: Florence Glanfield*	***Comparing the effects of two inquiry-based teaching strategies on secondary students' conceptual understanding and achievement in mathematics: A mixed-methods approach***

This study compared the effects that Investigation and Exemplification, two inquiry-based teaching strategies, had on secondary students' achievement and conceptual understanding of the three primary trigonometric ratios. Thirty-five fourth form (grade 10) students from one secondary school in Dominica were randomly assigned to two groups. The researcher taught both groups; one using Investigation and the other using Exemplification. Mixed-methods were used to analyze students' responses on a pre-test and a post-test. Both groups had significant increases in achievement and conceptual understanding. However, the achievement and conceptual understanding of the Exemplification group was higher than that of the Investigation group.

Caroline Damboise *Institution: Université de Montréal* *Supervisor: France Caron*	***Foster the development of reasoning using dynamic geometry software in future high school mathematics teachers***

Mathematical reasoning is one of the competencies aimed in high school (MELS, 2006), but a research by Mary (1999) mentions that future teachers seem to give less emphasis on validation and proving processes as components of this reasoning. My thesis hypothesizes that a sequence of activities showing the complementarity of the proving processes and explorations with GeoGebra could help future mathematics teachers better understand these issues.

The theoretical framework integrates elements of anthropological theory (Chevallard, 1998) and instrumental approach (Vérillon and Rabardel, 1995; Trouche, 2007; Guin and Trouche, 2002). The

construction of the sequence is based on theoretical benchmarks: robust and soft constructions (Soury-Lavergne, 2011), figure/drawing distinction (Laborde and Capponi, 1994) and deductive network (Tanguay, 2006).
Following the analysis of the data collected, it was found that the sequence contributed to the participants' instrumentation with regard to the software used and had, for some of them, an impact on their vision of the development of mathematical reasoning in mathematics education at secondary level. Modifications are proposed to improve the sequence of activities.

Shana Graham *Institution: University of Regina* *Supervisor: Kathy Nolan*	***Disrupting euro-western onto-epistemologies: (re)imagining possibilities for mathematics education through/with indigenous knowledges and complex conversations***

My doctoral thesis is a representation of my research into interfacing Indigenous knowledges and mathematics education. This focus arose as I became aware of the misframing of mathematics as universal/uncontestable and its uses within the field of mathematics education to mathematize/superimpose particular onto-epistemologies onto Indigenous worldviews, perhaps as mechanisms of control and assimilation. I adopted a form of story/autoethnography as methodology, hoping that including vignettes of my experiences with interfacings and (re)imaginings might resonate with and invite readers to think about broader issues of decolonization and Indigenous revitalizations. As a Settler Canadian, my research led me to question whether it is even appropriate for me to try to engage with Indigenous knowledges. However, I remain encouraged to do so because learning from various perspectives consistently assists me in disrupting, challenging and changing aspects of my present contexts by opening myself (mind/body/emotion/spirit) to being otherwise.

Oyemolade (Molade) Osibodu *Institution: Michigan State University* *Supervisor: Beth Herbel-Eisenmann*	***Critical Mathematics Education Towards Epistemic Freedom: Exploring Njo's Journey***

Set within the critical mathematics education (CME) landscape, I describe how Njo, a Gambian youth began a shift towards *epistemic freedom* during a semester-long co-exploration to understand if and how Sub-Saharan African (SSA) youth saw the role of mathematics in understanding social issues in their contexts. Using narratives, I describe how Njo saw her mathematics identity anew, disrupted colonial discourses of the school mathematics curriculum, raised her awareness and valuing of multiple ways of knowing, and lastly, began to see multiple ways of knowing in mathematics that were previously hidden

to her. Through engaging with decoloniality, SSA frameworks, cultural artifacts, and reflecting on her prior mathematics experiences, Njo began to claim authority of her mathematics knowledge. The findings point to the necessity for expanding CME's understanding of social justice as not only considering issues of justice at present, but also redressing cognitive injustice that calls to the past.

Gurpreet Sahmbi *Institution: Ontario Institute for Studies in Education (OISE) of the University of Toronto* *Supervisor: Douglas McDougall*	***A Tale of Two Universities: Investigating Factors Affecting the Secondary to Tertiary Transition into Calculus for Students in STEM Disciplines***

This study investigated factors affecting the secondary to tertiary transition into calculus for students in STEM disciplines. Using a mixed methods approach, data from two Ontario-based institutions was collected: 1) large-scale student data including prior mathematics grades linked to first-year calculus achievement; and 2) semi-structured interviews with professors/instructors/administrators associated with first-year calculus. Findings suggest that prior mathematics achievement (i.e., secondary-level) is a positive predictor for first-year calculus achievement. Participants perceived that students experience mathematics in K-12 in ways that are incongruent with tertiary expectations. STEM students in mathematics courses may also experience changes in identity and mental health at the transition. Though institutions are exploring ways of supporting students, including discipline-based streams of calculus, systemic barriers persist. This study highlights the need for continued efforts to understand this transition through many perspectives, and a need for improved understandings of the (seeming lack of) continuum between K-12 and tertiary mathematics.

Xiong Wang *Institution: University of Alberta* *Supervisor: Elaine Simmt*	***Understanding Math Teachers' Participation in a PLN***

This study investigates mathematics teachers' interactive conversations in a Professional Learning Network (PLN) in an attempt to understand the affordances of their participation. It adopted interpretive inquiry as the methodology and complexity thinking as the theoretical framework. The research targeted one PLN to collect the archived data from which four blog posts and their comments were selected as illustrative examples. The results presented the diverse conversation structures through conversation weaving and conversation expanding as well as the multiple types of knowing emergent from the conversations inclusive of *mathematics-for-teaching*, *beliefs about teaching*, *social relationships*, *blog*

resources, and *recounting experiences*. The knowing of *mathematics-for-teaching* was enacted in the moments of mathematics teachers' participation in the conversations. The other four types of knowing were implicated with the emergence of *mathematics-for-teaching*, the teachers' participation in the PLN, and the evolvement of the PLN itself, but they have not yet been explored in the predominant research on teachers' disciplinary knowledge of mathematics.