UNIVERSITÉ LAVAL

CANADIAN MATHEMATICS EDUCATION STUDY GROUP

36TH ANNUAL MEETING

MAY 25 TO MAY 29, 2012

ANNOUNCEMENT AND PROGRAM

We're happy to welcome you to Université Laval for the 36th Annual Meeting of CMESG which opens at 16:45 on Friday, 25 May and closes at 12:30, Tuesday, 29 May. The meeting of GDM, the Groupe de didacticiens des mathématiques du Québec, on May 23-25, will precede our meeting. For the occasion, you are warmly welcomed to attend the GDM panel debate featuring Erik De Corte (University of Leuven, Belgium), Fernando Hitt (UQAM), David Reid (Acadia University), Dominic Voyer (UQAR), and Alain Goupil (UQTR), scheduled for 14:00 on Friday, May 25. For more details, please consult the "Preconference Activities" section.

Université Laval is located in the western part of Québec city (Ste-Foy). To locate the university and its various components, you can visit www.ulaval.ca. Click on *English* in the upper right corner, if needed. Then select *Campus Map* (which is available in French only). In *Liens utiles,* underneath the campus map, you will find a link to a Google map, which might be helpful.

WELCOME AND REGISTRATION

On Friday, all activities are held in Pavillon Charles-De Koninck (no 13 on the Campus Map). Registration starts at 14:30. Cocktail (at 16:45) and dinner (at 17:45) are in the Atrium (level 0). The opening session (18:45) and the first plenary (19:30) will be in the same building but rooms cannot be booked at this time, so this is to be confirmed (some time in April).

You will also be able to register from 8:00 to 9:00 on Saturday May 26 in Pavillon Adrien-Pouliot by the main entrance, on avenue de la Médecine.

HOW TO GET THERE

*** From the Québec International Airport,** a cab ride to the University residence (Pavillon Alphonse-Marie-Parent) should cost approximately $25.

*** By car, from highway 20,** follow the signs for Québec City. Once you have crossed the St-Lawrence River (Pont Pierre-Laporte), aim for boulevard Laurier. The university campus will be on your left after approximately 2.5km on Laurier. The exit is clearly indicated.

*** By car, from highway 40,** take the exit for Du Vallon Sud which takes you on the western side of the campus: take the exit for the university from Du Vallon.

PARKING

Parking is free everywhere on Saturdays, Sundays and after 20h00 on Fridays. Also, the visitor's car park at level 00 of Pavillon Alphonse-Desjardins is free every day after 16h30. At all other times, you can use the parking meters (usually limited to 2 hours) but it is best to go to any of the visitor's car parks where you can buy at an automated machine a day-parking ticket giving you unlimited parking everywhere on campus for $14 a day. Note: there is a visitor's car park across from Pavillon Pouliot.

ACCOMMODATION

Université Laval has standard student accommodation for visitors and participants of the conference. Room description and general information is available at www.residences.ulaval.ca. Go to *Short term accommodation* (*Hébergement hôtelier*), select English and look at the *Our rooms* for a description. Note that the website has useful links to some of Quebec attractions, bus services, etc.

- Cost for a regular room is 52$ for a single and 65$ for a shared room (two single beds).
- Rooms with private bathroom, television, fridge, etc., are available at 85$
- Breakfast at the main cafeteria is included (Pavillon Alphonse-Desjardins).

To book a regular room, select *Packages and rates*. On the right hand-side of the screen, you will see a cryptic indication: CLICK HERE TO MAKE A RESERVATION. Everything should be fairly clear from then onwards: choose the *Conventions and Conferences* and at the bottom of the form, under the pop-up menu *Congress*, choose the GCEDM/CMESG conference.

To book a room with private bathroom, you need to contact the residences by e-mail at hebergement@sres.ulaval.ca or by phone 418-656-5632. Make sure to mention that this is for GCEDM/CMESG.

The residences are available if you want to arrive before the conference or stay after. A frequent bus service (route 800 and 801) between the university and the old-town makes it a good place to visit Québec.

CHECK-IN (RESIDENCES)

Check-in at Pavillon Alphonse-Marie-Parent (no 25 on the campus map) at the check-in desk 1618, opened 24 hours a day. Rooms are usually available at 16:00. Parking is included: you will be given a parking permit.

HOTEL

We have booked a block of rooms at Hotel Universel, a 15 minute walk from Pavillon De Koninck. The cost is 119$ per night for one person, 129$ for two. Reservations 1-800-463-4495 by April 25. (Conférence GCEDM/CMESG – group no 135514)

MEALS

All lunches and dinners will be taken together as a group, mostly on campus. Dinners on Sunday (Île d'Orléans) and Monday (on our own) will allow us to enjoy some of the sights that Québec can offer.

EXCURSIONS

Québec is a gorgeous city and there is plenty to visit. The website offered by the city can be very useful www.ville.quebec.qc.ca/touristes. The evening of Monday May 27 is free and you will also be offered the possibility of stopping in the old town on the way back from the excursion on the Sunday.

EMERGENCY

The department of mathematics and statistics (regular working hours) is (418) 656-2971. For the duration of the meeting, Frédéric Gourdeau can be contacted for emergencies on his cell phone at (418) 809-2347. The university has a security service available at all times at 418-656-5555.

PRE-CONFERENCE ACTIVITIES: "COLLOQUE GDM-2012"

The sequencing of GDM 2012 (May 23 to 25) with the annual meeting of CMESG (May 25 to 29) will allow participants from both groups to meet and participate in common activities. In particular, the participants of the CMESG meeting are warmly invited to attend the GDM panel debate on the theme of problem solving, featuring confirmed panelists Erik De Corte (University of Leuven, Belgium), Fernando Hitt (UQAM), David Reid (Acadia University), Dominic Voyer (UQAR) and Alain Goupil (UQTR), scheduled for 2pm on May 25. See the insert for further information.

Also, all CMESG members who wish to attend the rest of the GDM activities are kindly invited to register through contacting Izabella Oliveira (Izabella.Oliveira@fse.ulaval.ca) of the local organizing committee.

FEES

The conference fee ($210 if registration is received by April 23 and full payment by April 30th, $240 thereafter) covers the cost of the reception on Friday, lunches on Saturday, Sunday and Monday, dinners on Friday, Saturday and Sunday, coffee breaks, the excursion, and assists in 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 at http://publish.edu.uwo.ca/cmesg/. 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 web site at publish.edu.uwo.ca/cmesg/.

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: Margaret Walshaw *Massey University, New Zealand*	***Towards an understanding of ethical practical action in mathematics education: Insights from contemporary inquiries***

This presentation is an exploration of contemporary thinking about social justice within mathematics education. Underlying the interrogation is a search for a way to explain patterns of systemic underachievement and to describe what it means to practice equitably. The exploration is built on an understanding of mathematics education as a construct, situated within institutions, historical moments, as well as social, cultural and discursive spaces. In this formulation, social conditions and political dimensions are all highly significant.

The presentation first draws attention to a range of theoretical issues that are couched within conventional liberal democratic explanations of social justice. The move is then away from the mechanisms offered by those explanations towards insights from contemporary social theory that seek to explain how practices and identities are produced within discourses. Using examples from everyday life in mathematics classrooms, the aim is to highlight the lived contradictions of mathematics teaching and learning and to capture the politics of knowledge production and identity construction. Sketching out how students' diverse sociopolitical realities impact on the types of mathematical identities and the level of mathematical proficiency offered them in the mathematics classroom, and drawing attention to how systemic constraints become lived as individual teacher dilemmas, opens up an alternative space for thinking about mathematics classrooms. In drawing attention to our ethical obligation to transform classroom arrangements that impede the production of knowledge, the presentation not only affirms the potential of the radical democratic project, but also offers a way of understanding what we might do to effect change.

Lecture II: Paulus Gerdes *Vice-President for Southern Africa, African Academy of Sciences, Chief Advisor for Research and Quality of Education, ISTEG-University, Boane, Mozambique*	***Old and new mathematical ideas from Africa: Challenges for reflection***

The presentation will give some examples of mathematical ideas in the history of Africa, from the earliest times to the present. The varied examples will come from different cultures, from the South to the North, from the West to the East.

The frequent interweaving of mathematical and artistic ideas in diverse cultural practices, both male and female, will be underscored. Also examples of mathematical exploration and research by crafts(wo)men will be presented. The mathematical potential of some mathematical ideas embedded in African cultural traditions will be shown through the example of 'sand drawings' from Eastern Angola and 'mat designs' from North-East Mozambique, leading to the invention of 'cyclic matrices' with attractive geometric-visible properties.

Members of the CMESG will be challenged to reflect about possibilities to incorporate some of these old and new mathematical ideas into mathematics education in Canada. Challenged also to reflect about experiences and possibilities to embed mathematical ideas from other diverse cultural contexts into mathematics education.

ELDER TALK

William Higginson	***Cooda, Wooda, Didda, Shooda: Time Series Reflections on CMESG/GCEDM***

One of the Study Group's early members (participating parent) looks back to the organization's origins (dim memories), moves on to a review of its choices and trajectory (been there, did that), and finishes with a concise consideration of potential priorities for 21st century Canadian mathematics education (fast forward to a fuzzy future).

PANEL

What is fundamental mathematics for learners?

Peter Taylor, *Professor of Mathematics Queen's University*

Ralph Mason, *Professor of Mathematics Education University of Manitoba, and former school teacher*

Darien Allan, *High School Mathematics Teacher New Westminister Secondary School, and Doctoral Student Simon Fraser University*

Hélène Paradis, *Responsable des programmes de mathématique, Direction générale des services à l'enseignement, Ministère de l'Éducation, du Loisir et du Sport, Québec*

Ruth Beatty, *Assistant Professor Lakehead University and former special education teacher*

The mathematics curriculum is a concern for all of us in mathematics education in Canada. In the past decade we have seen the reworking of programs of study for K-12 mathematics. Although the process of curriculum reform differs somewhat across the provinces, at the core of the reform are beliefs about what is fundamental mathematics for children, youth and adults.

We asked our panelists, whom were selected based on their different backgrounds in mathematics education and different responsibilities today in the Canadian mathematics education community, to respond to the question, "What is fundamental mathematics for learners K-16 (primary school to university)?" Responding to our question are colleagues from across the country.

WORKING GROUPS

Working Group A *Leaders: Peter Liljedahl, France Caron*	***Numeracy: needs, affordances, and challenges***

In the last 10 years there has been an increasing awareness of, and attention paid to, the notion of numeracy in the K-16 system. But what is this thing we call numeracy and what is motivating the world-wide call for students to be more numerate? Given that mathematics has, for a long time, been part of the core compulsory curriculum, does the rise of numeracy aim at something different from, yet related to, the learning of mathematics? Or does it concern a particular outcome of the mathematics curriculum? In this working group we will:

- Explore what numeracy is, how the notion may have evolved in recent years, how and where it has been used, and how it stands together with, or apart from mathematics, arithmetic, mathematical literacy, and quantitative literacy.
- Explore what the affordances of numeracy are and what need it satisfies within the K-16 system.
- Engage in a number of numeracy tasks and examine what constitutes such a task from design to assessment and everything in between.

Intended participants are encouraged to explore the place of numeracy (or mathematical literacy) in their local K-12 curriculum and/or their tertiary setting prior to the meeting. Further readings for participants (before or after the meeting) are:

- Innumeracy – *John Paulos*
- The Drunkard's Walk – *Leonard Mlodinow*
- Mathematics and Democracy: The Case of Quantitative Literacy – *MAA* (http://www.maa.org/ql/mathanddemocracy.html)
- Learning a Living: First Results of the Adult Literacy and Life Skills Survey – *OECD* (http://www.oecd.org/dataoecd/44/7/34867438.pdf)

Working Group B *Leaders: David Wagner, Bev Caswell*	***Diversities in Mathematics and their Relation to Equity***

Any human interaction has people with different backgrounds and orientations addressing together a shared experience. Mathematical interactions are like this too, so mathematics is a field built on thinking in diverse ways. There are some special features of mathematical discourse that may highlight certain differences and obscure others. This working group will explore the various kinds of diversities that operate when people do mathematics together. Recognizing diversities as resources, the working group leaders and participants will share some of what they have noticed about the kinds of diversities in mathematics classrooms, including cultural diversity and linguistic diversity. However, our goal is to use this sharing as a starting point from which our group can extend our views to consider other diversities and their relation to each other. For example, we might think about diverse forms of representing mathematical ideas and how these relate to culture or language. For this stretching, we will do some problem solving together and reflect on this shared experience. We will ask what kinds of mathematical tasks might best draw out productive diversities.

Our exploration of diversity in mathematical discourse will be focused on an interest in equity and how we might address equity in mathematics classrooms. Our conception of equity includes multiple aspects, following Gutierrez's (2012) focus on fairness and the critical axis of power and identity, with special attention to typically marginalized students and their potential contributions to the development of mathematics.

We will address questions like the following: What do the diversities we notice tell us about power relations in mathematical interactions in schools and elsewhere? And what might the recognition of diversities as resources do for us when we lead or participate in mathematical discourse? How does this relate to equity? In the design of learning environments, what mathematical activities and interactions honour or draw on cultural and linguistic knowledge while developing mathematics? Also, what do present practices in mathematics education and professional development environments say about these questions?

Gutiérrez, R. (2012). Context matters: How should we conceptualize equity in mathematics education? In Herbel-Eisenmann, B., Choppin, J., Pimm, D. & Wagner, D. (eds.) *Equity in discourse for mathematics education: Theories, practices, and policies* (pp. 17-34). New York: Springer. [an earlier version of this chapter is available at http://tinyurl.com/6punnlk]

Working Group C *Leaders: Chantal Buteau, Nathalie Sinclair*	***Technology and Mathematics Teachers (k-16)***

Whether we like it or not, want it or not, it is a matter of (very short) time before digital technology is available at all time and for each individual in our mathematics classrooms (e.g. through Smartphones, Tablets, laptops, etc.). Not only does it allow full-time access to many mathematics software (e.g., graphing calculator, Dynamic Geometry, Dynamic Statistics, etc.) beyond traditionally scheduled computer labs, but it also opens to new possibilities such as using Wolfram Alpha, apps, and digital textbooks. Unlike previously, the technology is present, learners are connected—the computer lab may well be a thing of the past. This raises questions such as:

- How should/can our practice in the mathematics classroom change to reflect this unavoidable reality?
- What issues (challenges and opportunities) do the K-16 teachers face when integrating digital technologies in their classrooms? And more specifically when integrating Smartphones, Tablets, etc. technologies?
- How can we better prepare teachers 1) to integrate technologies in a meaningful way; 2) to embrace this 'Smartphone reality' for a 'productive pedagogy'?
- How could/should we adapt our assessment? Should communication be adapted too? If so, how?
- Do (digital) textbooks adequately support teachers integrating technologies in their teaching? And how could teachers meaningfully integrate interactive digital textbooks in the classroom?

In this working group, we will address the questions above that are focused on the role of the teacher rather than on the task. Activities will be proposed to trigger reflection on the discussed topics. Participants are invited (not mandatory) to bring their Smartphone, Tablet, laptop technologies.

References

Section 3 *Teachers and Technology.* In C. Hoyles and J. Lagrange (Eds.), *Digital Technologies and Mathematics Teaching and Learning: Rethinking the Terrain*. New York: Springer, pp. 285-345.

Wilson, P. (2008). Teacher Education: Technology's Conduit to the Classroom. In K. Heid & G. Blume (Eds.), *Research on technology in the learning and teaching of mathematics: Volume 2: Cases and Perspectives*. Charlotte, NC: National Council of Teachers of Mathematics/Information Age Publishing.

Zbiek, R. and Hollebrands, K. (2008). A Research Informed View of the Process of Incorporating Mathematics Technology into Classroom Practice by In-service and Prospective Teachers. In K. Heid & G. Blume (Eds.), *Research on technology in the learning and teaching of mathematics: Syntheses, cases and perspectives. Volume 1: Research syntheses*. Charlotte, NC: National Council of Teachers of Mathematics/Information Age Publishing.

Working Group D *Leaders: David Reid, Denis Tanguay*	***Proof in mathematics and in schools***

The work of researchers in mathematics involves reading proofs, making conjectures, looking for proofs of conjectures and writing publishable proofs. But school mathematics is not research mathematics and its aim is not necessarily allowing students to do mathematical research. Hence, the transposition of proof from one context to the other is not straightforward. A large body of work on proof, in both contexts, now exists, but it raises as many questions as it answers. In this working group we will consider some key questions related to the transposition of proof from mathematical researchers' practice to schools. These include:

- What proof related activities in research mathematics (e.g., reading proofs, conjecturing, exploring examples and counter-examples, narrowing or even changing the question, adapting definitions or theories, etc.) should be part of school mathematics? Which should come first, at which school levels, and what kind of coordination could or should be considered?
- What should be the role of proof in school mathematics? Should proof be primarily a means of verification, explanation, exploration? Or simply a ground for learning 'good logical thought'? Or something else?
- Is conjecturing a motivation and support for proving, or an obstacle to it?
- What kinds of proofs should students be exposed to, or expected to produce, at each school level?
- What role does (formal) logic have in proof teaching and learning? If logic has a role, how should it be taught? As a specific topic? Or throughout the entire (post-primary?) mathematics curriculum?

References

Barrier, T., Durand-Guerrier, V., Blossier, T. 2009. Semantic and game-theoretical insight into argumentation and proof. In F.-L. Lin, F.-J. Hsieh, G. Hanna, M. De Villiers, (Eds.) *ICMI Study 19 Conference Proceedings, Proof and Proving in Mathematics Education*, vol. 2, pp. 232-238. Taipei, Taïwan. Online at

http://140.122.140.1/~icmi19/files/Volume_1.pdf#page=112

de Villiers, M. 1999. *Rethinking Proof with Sketchpad*, Introduction. Key Curriculum Press. Online at http://academic.sun.ac.za/education/mathematics/MALATI/Files/proof.pdf

Grenier, D. 2006. Des problèmes de recherche pour l'apprentissage de la modélisation et de la preuve en mathématique. *Actes du colloque de l'Association Mathématique du Québec (AMQ)*, Sherbrooke, Québec. Disponible sur le web, à la pa`ge 155 du document http://newton.mat.ulaval.ca/amq/Documents/actes2006.pdf

Grenier, D. et Tanguay, D. 2008. L'angle dièdre, notion incontournable dans les constructions pratique et théorique des polyèdres réguliers. *Petit x*, n°78, pp. 26-52. Disponible sur le web à http://www.math.uqam.ca/~tanguay_d/Pdf%20des%20articles/Petitx78_DGDT.pdf

Tanguay, D. & Grenier, D. 2010. Experimentation and Proof in a Solid Geometry Situation. *For the Learning of Mathematics*, n°30 (3), pp. 36-42. For a related article, see http://140.122.140.1/~icmi19/files/Volume_2.pdf#page=241

Working Group E *Leaders: Susan Gerofsky, Peter Appelbaum*	***The role of text/books in the mathematics classroom***

There is a North American tradition of 'leaning' heavily on the textbook in mathematics classes -- for the sequencing and introduction of topics, and provision of examples and exercises. In some sense, the prescribed mathematics textbook is often taken to be the curriculum. This is in contrast to literature classes (which seldom have a single textbook), or art or music classes (rarely using textbooks at all).

Textbooks are changing though, and are already starting to look more like iPads than the familiar dog-eared, graffitied, duct-taped bundles of paper. This leads us to reconsider the nature and future of text/books in the mathematics classroom. Who might write them, and who read them? How do textbooks address their audience? How are they designed? What intended purposes do they serve, and what are their unintended effects? How have, and how will textbooks change over time?

In this working group, we will consider text/books broadly, including linguistic, multisensory, design and contextual aspects of texts. Our aim will be a deeper understanding of the cultural phenomenon of mathematics textbooks, their history and future. Topics will include:

- ways to undertake discourse analysis, textual analysis and genre analysis of textbooks
- the agency and positioning of text/books: how the text reads the reader as the reader reads the text
- archaeology and genealogy of textbooks: considering historical textbooks (for example, Robert Recorde's books, or a math textbook from Franco's Spain) and proto-textbooks (the Passover Haggadah and other ancient works as teaching texts)
- sociocultural and political entailments of textbooks
- teacher- and student-made open source electronic textbooks
- experiential texts (for example, a school garden as mathematics text)

Working Group F *Leaders: Hassane Squalli, Chris Suurtaam, Viktor Freiman*	***Preparing teachers to develop algebraic thinking in primary and secondary school***

In 1990s, a international movement known as Early Algebra emerged to reform teaching algebra in school. Early Algebra was thought not as preparation of elementary students to high school algebra but rather as a way to develop algebraic thinking in children related to a variety of notions and concepts, such as operation, equality, equation, pattern, formula, property, variable, and variation. The movement influenced 2000s school curriculum reform in several countries and Canadian provinces. For example, the Ontario 1-8 math curriculum framework has patterning and algebra among five structural components. Based on studying patterns, new curricula see conjecture and generalization as central ideas of emerging algebraic thinking. This new vision of algebra and the development of algebraic thinking pose important challenges for teachers and teacher classroom practice, especially in primary grades.

Our working group will reflect on following three questions:

1) How to prepare teachers to deal with challenges related to algebraic thinking as 'having algebraic eye and vision' (Kaput)? What can be done within pre- and in-service teachers' preparation and development programs?

2) What challenges do teachers meet when they work with students on developing algebraic thinking and can teachers be supported to overcome those challenges?

3) Generally speaking, what can teachers draw from research related to algebra teaching and learning?

TOPIC SESSIONS

Topic Session A *Miroslav Lovric*	***Collaboration Between Research in Mathematics Education and Teaching Mathematics: Case Study of Teaching Infinity in Calculus***

In words of Michèle Artigue "existing research [in math education] can greatly help us today, if we make its results accessible to a large audience and make the necessary efforts to *better link research and practice*." I plan to illustrate how these links between research and practice help me prepare lectures and class activities in teaching infinity within the context of (but not limited to) first-year calculus. Infinity belongs to a collection of those difficult mathematics concepts which are often in conflict with our intuition and understanding of real numbers. Teaching infinity consists of a hard task of stimulating students to reconstruct their existing cognitive models and engage in genuine abstract thinking. As well, I will comment on the ways infinity is covered in university mathematics textbooks. Rather than being general, I will be specific in describing my approach to teaching infinity, in the hope of hearing useful and constructive critiques.

Artigue, M. (2001) What can we learn from educational research at the university level? In D. Holton (Ed.), *The Teaching and Learning of Mathematics at the University Level: An ICMI Study* (pp. 207-220). The Netherlands: Kluwer Academic Publishers

Topic Session B *Louis Charbonneau, David Guillemette*	***Reading original texts in the mathematical classroom***

In this session, we will work on a selection of short ancient original texts. A discussion will ensue from the reading of these texts around the following questions:

- What does it means to "read" an original text ?
- Why read an original text? What outcome, historical, mathematical or other, should be expected from such reading?
- Is the reading of original texts a valuable activity in the classroom and, if so, in which classroom (high school, university mathematics, education or engineering classes or others)?
- What knowledge and skill sets might be a prerequisite to such reading?
- Are all texts suitable for such reading?

NEW PHD SESSIONS

Lily Bacon	***Negotiated construction in the context of teachers' knowledge in pre-service teacher education programs***

Teacher education programs in Quebec are based on the generally accepted idea that the experience coming from the practice and an analysis of that experience is the key driving forces for the professional development. However, when the primary teacher education is concerned, research shows that the exchanges between pre-service teacher and their trainers rarely appear in a didactic analysis of the educational intervention, thus missing out important issues related to student learning. This has led to the recommendation for further involvement of didactics into training practices. Our doctoral research is therefore interested on collaboration between a pre-service teacher, a teacher and a supervisor-didactician in a context of practice. We have used the concepts of professional didactics to analyze relationship between these partners and reporting teachers' knowledge or mathematics that is organized through their interactions.

Bev Caswell	***Teaching toward equity in mathematics***

This research is a qualitative case study examining changes in urban Canadian elementary teachers' conceptualizations of equity and approaches to pedagogy in their mathematics teaching in relation to their involvement in multiple professional learning contexts. The study focuses on four major professional development (PD) efforts in which five focal teachers participated over a school year. Data sources include researcher observations, field notes, video-recordings of PD sessions and classroom mathematics teaching, as well as a series of one-on-one interviews. Data analysis revealed three main ideas related to equity that were adopted by focal teachers: 1) the importance of developing awareness of students and their communities; 2) teaching strategies to scaffold students' development of mathematical proficiency; and 3) strategies for structuring student-driven, inquiry-based learning for mathematics. The multiple contexts of professional learning presented contradictory messages. Thus, teachers took up some ideas and left others behind and sometimes took up ideas that served conflicting goals of education. Future studies of teacher PD should focus on the teacher's perspective and the role of any individual PD within the multiple contexts of professional learning in which teachers participate.

Elena Halmaghi	***Undergraduate Students' Conceptions of Inequalities***

Inequalities are vital in the production of mathematics. They are employed as specialized tools in the study of functions, in proving equalities, and in approximation or optimization studies, to enumerate only a few areas of mathematics where inequalities are put to work. The concept of inequality, however, is problematic for high school and university students alike. Moreover, the school curriculum seems disconnected from the role of inequalities in mathematics and mostly presents inequalities as a subsection of equations. The placement of inequalities in the school curriculum and the disconnect between school mathematics inequalities and a mathematician's approach to inequalities take the blame of research in mathematics education reporting on students' misconceptions when dealing with this concept. This study moves from the theory of misconceptions to a framework of undergraduate students' conceptions of inequalities. In an effort to learn more about what students 'see' when dealing with inequalities, three research questions are pursued: What are undergraduate students' conceptions of inequalities? What influences the construction of the concept of inequalities? How can undergraduate students' conceptions of inequalities expand our insight into students' understanding of, and meaningful engagement with, inequalities?

Data for this study was produced mostly through learner-generated examples of inequalities that satisfy certain conditions. The participants in the research were undergraduate students enrolled in two mathematics courses - a foundations of mathematics course and a precalculus course. The results of this research are five conceptions of inequalities. It was also found that the undergraduate students' conceptions of inequalities mostly occupy the lower regions of Tall's 'Three Mental Worlds of Mathematics'. The speculation is that what Tall calls the 'met-befores' as well as what I call the 'missed-befores' influence the construction of the concept of inequalities. Curriculum suggestions for preparing the ground for the work on and with inequalities are presented. This study contributes to ongoing research on mathematics concept formation.

Manon LeBlanc	***The study of on-line situations of validation experienced by 13 and 14-year-old students with and without the aid of an electronic forum***

The development of reasoning abilities is one of the fundamental goals of learning mathematics as reasoning is crucial to its understanding. A second essential goal is the development of proof. Closely related to reasoning, the notion of proof enables the students to derive meaningful understanding of concepts through the logical explanation of their work. However, in spite of the emphasis placed on the development of different types of reasoning, students are still encountering difficulties when developing or evaluating proofs.

In this project, we were interested in the development of proofs using an electronic forum, an on-line communication tool allowing interactions between students and teachers. This choice is based on research that shows that the use of this kind of tool sidesteps a number of constraints inherent to the school system (for example, the time factor) while taking into account characteristics considered determining for the development of proofs such as the social aspect. This study was twofold. Firstly, it examined the impact of the use of an electronic forum on the development of algebraic validation skills among 13 and 14-year-old students from Québec and New-Brunswick. Secondly, it focused on the development of skills linked to the evaluation of proofs in algebra within the same group of students. We worked with four classes (four teachers and 119 students) distributed in an experimental group and a control group. After the pretest, four activities linked to algebra were completed over a period of four months. The work which students carried out focused on the following three components: problem solving, the validation of solutions and the comparison of solutions in order to determine which ones were the most convincing. A posttest was administered at the end of the four months. The results seem to indicate that the use of the electronic forum fosters the transition from pragmatic proofs to intellectual proofs and facilitates an appropriate use of the rules of the mathematical debate.

Geneviève Lessard	***Institutional acculturation of the researcher, teacher, and Secondary 1 students with learning difficulties in the problem situations involving rational numbers***

Our research focuses on the transforming the way Secondary 1 students with learning difficulties deal with rational numbers. . As shown by several studies, the major challenge is to not get stuck in the vicious circle of reducing learning issues and learning opportunities related to rational numbers for students with learning difficulties. To meet this challenge and rebuild a didactic memory thus giving hope (Brousseau and Centeno, 1998), we focused on the 'ecological inscription' of rich and original situations helping in coordination of 'knowledge learned' (connaissances) and 'knowledge taught' (savoirs) . In a process of acculturation, the ecological approach seems to be a good referential to think of "didactic detransposition/re-transposition" (Antibi and Brousseau, 2000). Our research aims to: 1) to describe the progression of institutional processes of acculturation of the teacher, researcher and students and their effects on the process of development and management of teaching situations, 2) specify the evolution of students' knowledge, habits and relationships with rational numbers. Our integration in the classroom for a period of six months, allowed us to assess the effects of the approach implemented in the joint didactical action of the teacher, student, researcher. We noted significant changes in the topogenesis and chronogenesis of knowledge manifested particularly by students by means of: a) significant investment in complex situations; b) the adoption of mathematical practices more responsive to numerical data and relationships between these data, c) the appearance of "unusual" and, at first look, 'useless' quite complex ideas. The results of our study support therefore the undeniable importance of considering students with learning difficulties as mathematically competent, as emphasized by Empson (2003), Houssart (2002)

and Squalli, and Mary Theis (2011). The wealth of situations and didactic contracts that they solicit seem even more revealing in terms of the richness individual variations than the only psychogenic characteristics of students (Fuchs, Powell, Seethaler, Cirino and Fletcher, 2008).

Jean François Maheux	***Mathematics Education: An Aporetic of Epistemology, Language and Ethics***

Writing research in mathematics education, one is commonly asked to present questions, methods, concepts and findings, as if the research and the writing itself were mere intentional activities by mean of which "knowledge" is produced. Tout à l'opposé de cette vision volontariste, Derrida explique comment écrire (et je propose d'ajouter « faire de la recherche », mais également toute entreprise de « connaissance » y compris les explorations mathématiques des élèves) évoque plutôt une « descente hors de soi en soi du sens … métaphore comme possibilité d'autrui … où l'être doit se cacher si l'on veut que l'autre apparaisse ». From such a perspective, researching teaching and learning are moments/occasions in which knowing in mathematics education is always already knowing-with one another, and therefore constitutes an ethical relation… pour laquelle tout indique qu'il nous faut un nouveau langage.

Susan Oesterle	***Diverse Perspectives on Teaching 'Math for Teachers': Living the Tensions***

While many post-secondary institutions offer mathematics content courses for prospective elementary school teachers within mathematics departments (MFT courses), very little is known about the nature of these courses or the instructors who teach them. This presentation will report on results of a study that begins to fill this gap in the research through a qualitative analysis of interviews with 10 MFT instructors, all faculty in mathematics departments at universities or colleges in British Columbia, offering insight into their diverse interpretations of the course and, particularly, the tensions they experience. Three levels of tensions will be articulated and contributing factors considered, including indications of influential norms at work in post-secondary mathematics instructional contexts. While tensions cannot always be resolved, their identification offers avenues for positive change. These avenues will also be explored during the presentation.

Armando Paulino Preciado Babb	***Conversations held and roles played during mathematics teachers' collaborative design: Two dimensions of interaction***

The focus of this study is on interactions among teachers, and other participants, in the collaborative design of mathematics teaching and learning artefacts. There is a variety of modalities of collaborative design of these artefacts around the world, and research has shown the benefit of this activity for students' learning and teachers' professional growth. My purpose in conducting this study was to understand what happens inside these teams of collaborative design in terms of participants' interactions and activities. I decided to take a sociological approach in researching these interactions.

This research was conducted in three stages differing in the types of data sources and data generation. The first stage consisted of the study of a single case in which I participated as a member in a team of collaborative design. I analyzed the conversations and actions held during the design process identifying two emerging themes: (1) the focus of the conversations and actions, and (2) the roles held by the participants of collaborative design. I characterized interactions using these two themes, which I consider as dimensions of interactions in teachers' collaborative design. In the second stage of this study I looked at other cases of collaborative design.

Participants from three different modalities were contacted in order to identify resonances and dissonances with the case analyzed in the first stage. Lastly, in the third stage, three pieces of literature served as second-hand data to explore large-scale modalities of teachers' collaborative design. Considering all the cases included in the second and third stages, I refined, modified, and extended the characterization for interactions among participants in teachers' collaborative design. The resulting characterization for interactions serves as a language that acknowledges the diversity of both the settings in which collaborative design can be conducted and the participants' roles played in each case. Such characterization has implications for both practitioners and researchers in mathematics education interested in teachers' collaborative design and professional development.

Oana Radu	***The ordinary yet extraordinary emotions and motives of pre-service mathematics teachers***

This research study is an account of the emotional experiences encountered by interns while teaching mathematics in junior or senior high schools. It describes similarities and differences between the emotional experiences of interns with different goal orientations. The findings of this qualitative study show that mastery oriented and performance approach interns present

similarities in attributed causes of pleasant emotions, such as students understand math, do their homework, or are engaged in classroom activities. However, for mastery oriented interns, pleasant emotions relate to students' understanding, while for performance approach interns, pleasant emotions relate to their increased desire to appear talented at teaching. Performance avoidance interns attribute the causes of pleasant emotions to getting positive feedback from supervisors and students, or to not encountering significant classroom disruptions. Thoughts appearing in conjunction with unpleasant emotions show performance approach interns' affinity to attribute the causes to students' inappropriate behaviour or lack of attention. While experiencing unpleasant emotions, performance avoidance interns' thoughts run towards their inability to control the class, questioning their choice of a career, and even thinking about leaving the teaching profession. Furthermore, the case study portrayed the internship as a place where a mastery oriented intern can experience both pleasant and unpleasant emotions. It revealed how unpleasant emotions have a constructive effect, and described modalities used to overcome such emotions and to perfect teaching practices.

Mireille Saboya	***Development and analysis of a didactic intervention, co-constructed between researcher and teacher, for the development of a control of the mathematical activity among high school students***

Some components of the student's mathematical activity, such as: checking the result, the justification of a claim, a proposal or a strategy adopted in solving a problem, a reflective involvement into the task, and validation reflect the acquisition of what we call control. Several studies show the importance of these components in students' and mathematicians' mathematical activity; as well, they are also central in a school context. However, various studies highlight the lack of control exercised by students in mathematical activities, at all levels and in different areas of mathematics. This is consistent with the opinion of practicing teachers in terms of verification of the results and of the problem-solving process. Through a collaborative research conducted with a third grade high school teacher (students aged 15-16) we investigated the situations which are likely to develop control among students in algebra. The development of these didactic situations is based on a theoretical analysis of the concept of control. This research sheds light on one hand on the situations developed jointly and intervention strategies put in place in the classroom, and on the other hand allows us to better understand what happens in terms of development of control among high school students in these situations.