THE CANADIAN MATHEMATICS EDUCATION STUDY GROUP

34TH ANNUAL MEETING

MAY 21-25, 2010

SIMON FRASER UNIVERSITY, BURNABY CAMPUS

ANNOUNCEMENT AND PROGRAM

Welcome to Simon Fraser University, host of the 34th Annual Meeting of the *Canadian Mathematics Education Study Group* (CMESG). The conference will open for registration between 13:00 and 16:00 Friday, May 21, and will close at 12:45 on Tuesday, May 25. You may also register between 8:00 and 9:00 on Saturday May 22nd.

Simon Fraser University is located on top of the Burnaby Mountain in Burnaby, British Columbia. CMESG activities will take place in the **West Mall Complex** (WMC) close to the first bus stop (SFU Transportation Center, Bay 1) The entire conference zone has full accessibility for wheelchairs (and walkers), even the accommodations. You can visit www.sfu.ca for further details about the university; maps of the campus can be found at: www.sfu.ca/about/maps.html.

FEES

The conference fee ($200 if full payment and registration are received by **May 11th**, $225 thereafter) covers the cost of the reception on Friday, lunches on Saturday, Sunday and Monday, the dinner cruise, dinner on Monday and the 7 coffee breaks, and assists in other conference costs. The $225 is considered a late registration fee as catering companies are now charging a fee when the confirmed numbers of people for the events change.

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), as well as for persons accompanying participants if they are not taking part in the academic program activities. Please note: “ad hoc” presenters are required to pay the academic program fee.

HOW TO GET TO THE BURNABY CAMPUS OF SIMON FRASER UNIVERSITY

From Vancouver International Airport (YVR)

By taxi: approximate cost $70 – approximate time, 45 minutes.

By public transit:

- Option 1: Take Skytrain-platform sign **Canada Line** to Waterfront. Arrive to Waterfront station. Take bus **135 SFU** from Eastbound Hasting Street at Richards Street. Once at SFU Burnaby campus, get off at the first stop (Bay 1). Cost - $8.75 ($3.75 adult cash fare and $5 Canada line AddFare). Approximate time: 1.5 hours. For exact schedules visit www.translink.ca, where you will be able to enter your specific date of travel and time of departure. The connections are very good for both the Canada Line and the 135 SFU bus.

- Option 2: Take Skytrain-platform sign **Canada Line** to Waterfront. From Waterfront station, take Skytrain-platform sign **Millennium Line** to VCC-Clark. From the Production Way/ University station, take bus **145 SFU/Production Stn**. Once at SFU Burnaby campus, get off at the very first stop (Bay 1). Cost - $8.75 ($3.75 adult cash fare and $5 Canada line AddFare). Approximate time – 1.5 hours.

By car:

- Take the main road out of the airport following signs to Vancouver/New Westminster and proceed over the Arthur Laing Bridge. Follow the signs to Marine Drive (East).
- Continue on Marine Drive until you reach Boundary Road.
- Turn left and head North on Boundary Road.
- Turn right onto Hastings St.
- Follow Hastings St. East watching for signs directing traffic to SFU.
- Stay in the right lane as Hastings St. forks. Hastings St. becomes Burnaby Mountain Parkway as it heads up Burnaby Mountain to the University.
- Turn left where Burnaby Mountain Parkway meets Gaglardi Way. This is the entrance to the University.
- The first building you will see is the 24 hour Information and Security Office. You can park temporarily in front. Go in and ask directions to Residence and Housing.

From the East

By car:

- Take Hwy 1 Westbound. Get off at exit 37 to merge onto Gaglardi Way heading North up the mountain. Signs will indicate you are on the correct route for Simon Fraser University.
- Follow Gaglardi Way all the way up Burnaby Mountain to SFU.
- The first building you will see is the 24 hour Information and Security Office. Go past it, and 50 metres to the right is the Visitor North Parkade. (See information on Parking.)

From Vancouver downtown

By car:

- Take Hasting St. Eastbound all the way to the foot of the mountain, watching for signs directing traffic to SFU (soon after you see a mall with a Safeway, a Starbucks and a Dairy Queen on your right). Continue onto Burnaby Mountain Pkwy (making a slight right).
- Stay in the right lane as Hastings St. forks. Hastings St. becomes Burnaby Mountain Parkway as it heads up Burnaby Mountain to the University.
- Turn left where Burnaby Mountain Parkway meets Gaglardi Way. This is the entrance to the University.
- The first building you will see is the 24 hour Information and Security Office. Go past it, and 50 metres to the right is the Visitor North Parkade. (See information on Parking.)

By public transit: several buses are routed through the campus from different areas of the Lower Mainland. The center of the campus is a major hub for these buses. The direct bus routes to SFU-Burnaby are:

- #135 SFU from downtown Vancouver (135 BURRARD STN for return trip)
- #143 SFU from Coquitlam Centre Station (143 COQUITLAM STN for return trip)
- #144 SFU from Burnaby Metrotown Station (144 METROTOWN STN for return trip)
- #145 SFU from Production Way/University Station (145 Production Way STN for return trip)

Consult www.translink.ca for more information on the transit system.

PARKING

Parking on the university premises requires payment. The closest available parking to the West Mall Complex (WMC) is the Visitor North Parkade, located on University Dr. East 50 metres (to the West) from the first bus stop (Bay 1). The cost is $13 per day.

ACCOMMODATION

Accommodations will be available at the SFU Conference and Guest Accommodations (www.sfuaccommodations.ca), which is located on Burnaby Mountain west of the West Mall Complex (WMC).

Two room types will be available, each including a daily breakfast voucher: (1) Single Townhouse Room at $64.95 per night and (2) Single Form room at $50.00 per night. Please consult the website given above for detailed descriptions of each room type.

Rooms will be held for CMESG attendees until **April 15th**, so please make your reservations before then. To request a reservation, file a "Reservation Request Form," which can be found at www.sfuaccommodations.ca/reservations/index.html. The reservation form will be listed as "CMESG." You will be able to pay for your room using VISA or Mastercard. In case of

cancellation, you must provide at least 2 weeks notice. Cancellations with less than 14 days notice will be subject to a $35.00 cancellation fee. If you wish to book after April 15th, please contact SFU Conference Accommodations to make arrangements; this will be based on availability.

You can check in anytime after 15:00 and before midnight at the Admin Office, shown here: www.sfuaccommodations.ca/PDF/Directions/Directions%20to%20parking_09.pdf. If you arrive after 17:00 please stop at the Security and Information Centre, at the main entrance to the campus, just prior to the underpass. Security will notify on-call staff of your arrival and meet you at the Residence Office. Parking for guests staying on campus can be arranged at time of check in for a fee of $6.00 per day per vehicle. All vehicles must be registered and receive a parking pass.

MEALS

All breakfasts will be at the residence dining hall. Lunches will be taken together as a group at the SFU Highland Pub. Friday night there will be a reception, which will include refreshments as well as food. On Saturday night, participants will be free to enjoy dinner at one of Vancouver's many excellent restaurants (see bus information above for directions on how to get downtown) or at one of the restaurants in the Cornerstone building at the east end of campus. Sunday night dinner will be served as part of the excursion. Monday night dinners will be taken together at the SFU Highland Pub.

EXCURSION

The excursion on Sunday evening is a dinner cruise, which will depart from Coal Harbour in Vancouver and travel up the Indian Arm. The cruise goes from 18:30 to 22:30 and dinner will be served. Buses will pick participants up at the residence at 17:00 and drop them off at the end of the evening.

IN CASE OF EMERGENCY

For emergencies, contact Peter Liljedahl at 604.764.6764 or liljedahl@sfu.ca Here is some other contact information:

- SFU Security: 778.782.3100
- SFU Emergencies: 778.782.4500

PRE-CONFERENCE ACTIVITIES

CMESG Attendees are cordially invited to drop into Stephen (Sen) Campbell's CFI- and SSHRC-funded Educational Neuroscience Laboratory (the *ENGRAMMETRON*, www.engrammetron.net), in the Faculty of Education Building (EB 7504) on Friday, May 21st between the hours of 14:00 and 16:00. Sen will be presenting half hour overviews of the Lab beginning at 14:15 and 15:15, and will be happy to field any other questions that may arise in between. Directions for finding the Lab are available at: engrammetron.net/engrammetron/participate/directions.

Changing the Culture is a one day conference, sponsored by the Pacific Institute for the Mathematical Sciences, which, since 1998, brings together mathematicians, mathematics educators, and school teachers from all levels to work together towards "changing the culture" of school mathematics. This year, the conference will be held on Friday, May 21st, at the SFU Burnaby Campus. It will focus on resources –textbooks, teacher-created, internet, etc.– and how they impact and inspire (or impede) the teaching of mathematics. For more information, and links

to past conferences, see www.pims.math.ca/education/changing-culture. The conference is free but registration is required.

The 2010 *Sharing Mathematics Conference* will take place Thursday, May 20th from 9:00 to 16:30 at the Burnaby Campus of Simon Fraser University. *Sharing mathematics: A tribute to Jim Totten* is a conference about sharing love for mathematics and ideas about teaching mathematics. For more information and the program, see www.tru.ca/sharingmath/. The conference is free but registration is required.

WELCOME AND REGISTRATION

Registration will take place in the West Mall Complex (WMC) on May 21st between 13:00 to 16:00 and on May 22nd between 8:00 and 9:00, in the Atrium on the 3000 level. The plenary will begin at 16:00 and will be followed by the CMESG opening session at 17:00—both will take place in WMC 3520. There will be a reception between 18:00 and 21:00 at the SFU Highland Pub, where food and refreshments will be served. The SFU Highland Pub is located in the MBC Building, across from the library.

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 an application form please see our web site at publish.edu.uwo.ca/cmesg/.

FOR NEWCOMERS

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. You should select one of the six groups, based on the descriptions in this guide and the comments of the leaders on Friday evening. The task of the working group is to interact around a particular topic, with no prerequisite reading or experience and no post-conference obligations. Stay with the working group you select.

There are four **plenary speakers**, who will each address the whole conference. In contrast with other conferences, for two of the plenary presentations, the audience will break into small groups to discuss and prepare questions that will be presented to the speakers at a later time in the conference. Discussion with the third and fourth plenary speakers will occur during the plenary time noted in the conference schedule.

Two other kinds of sessions provide more traditional forms of presentation: during the one-hour **topic session**, select one of two presenters, and during the three half-hour **new PhD sessions**, select one of the two or three presenters.

You will also note three half-hour **ad hoc sessions**: any conference member is welcome to sign up during the conference to lead an ad hoc session, and participants will select from as many options as are scheduled.

There is one last kind of session that many of us consider the most significant: **meals**! Sit with those you know, or sit with those you are getting to know – the meals are an integral part of the conferring that makes CMESG such a special conference.

PLENARY LECTURES

Lecture I: William Byers

Ambiguity and Mathematical Thinking

Concordia University

"Mathematics teaches you to think!" We have all made this comment and, if we take it seriously, it has a great impact on how we teach. But what kind of thinking do we have in mind when we make this claim? Is there only one kind of thinking that is at play when we do mathematics? Many people feel that mathematical thinking is logical, linear, and, above all, clear. Let's call this way of thinking "simple." I will claim that (in the words of the French sociologist and philosopher of science Edgar Morin) mathematics uses "complex" thinking. One of our aims is to explore some aspects of complex thinking.

How the mind is used in mathematics leads directly to a picture of what mathematics is and what mathematics education is all about. Most teachers of mathematics work with an implicit set of dichotomies that we take to be obvious. For example, "knowing" is good, "not knowing" is bad. Clarity is good; vagueness is bad. Precision is good; ambiguity is bad. And so on. Learning, we may feel, means leading someone from the "bad" side to the "good". "We" (the teachers) don't have this problem since "we" are firmly established on the "good" side.

We devalue the "bad": mistakes, ambiguities, contradictions, and paradoxes. Yet these are the very things that characterize the domain from which learning arises. I shall try to convince you that we should focus more attention on this so-called negative area because this is where the action is; this is where learning happens. We are so blinded by the clarity and rationality of mathematical theory that we ignore its sources. The question, for example, is not how to avoid ambiguity, since it is unavoidable, but how to use it in a constructive manner.

Mathematics is primarily about ideas, not facts, techniques, or logic. If this is so then mathematics at all levels is fundamentally a domain of creativity and should be approached as such. You can't memorize ideas, you have to "get" them and this "getting" is an act of creativity. There is no formula for creativity; it is a process that is inherently discontinuous. Every mathematical situation needs to be approached through the question, "what is going on here?" that is, "what is the basic idea in this mathematical situation?"

Approaching mathematics from the perspective of ambiguity and mathematical ideas (the two are connected) leads to a different picture of what mathematics is and, as a consequence, how it should be learned and taught.

William Byers, *How Mathematicians Think: Using Ambiguity, Contradiction, and Paradox to create Mathematics*, Princeton University Press, (2007).

Lecture II: Marta Civil

Learning From and With Parents: Resources for Equity in Mathematics Education

The University of Arizona

In this presentation I draw on over fifteen years of working with low-income, Latino/a parents and mathematics education. I start with the theoretical concept of Funds of Knowledge, through which we learned FROM parents to then inform classroom teaching. In later projects focused on parental engagement and mathematics, the workshops and mini courses allowed us to learn WITH the parents. This led to the idea of parents as intellectual resources for the teaching and learning of mathematics. Through what we call "tertulias matemáticas" (mathematical circles), we engage in a

dialogue with parents to address issues related to their children's mathematics education. These dialogues, based on rapport and trust, allow us to look at these issues from a critical education point of view.

In the presentation I first describe different approaches to parental engagement in mathematics (e.g., home visits; workshops; "tertulias"; classroom visits). Then I report on findings from my research on the following themes:

1. Parents as adult learners of mathematics
2. Parents' perceptions about the teaching and learning of mathematics
3. Parents and valorization of knowledge
4. Parents and issues of language and mathematics (focusing on parents and children whose first language is not the language of schooling)
5. Parents - children interactions around mathematics

Listening to parents is of utmost importance to my work. The findings will be presented largely through parents' voices. My commentary will be in terms of implications for equity in the teaching and learning of mathematics based on what I am learning from my work with parents.

Lecture III: Bernard Hodgson
Université Laval

ICMI as a Space for International Collaboration and Exchange in Mathematics Education: some Views from a Canadian Perspective

From 1999 to 2009, I had the privilege of being the secretary-general of the International Commission on Mathematical Instruction (ICMI). This position has provided me with a unique context to both witness and participate in various actions aiming at fostering the development of mathematical education as considered from an international perspective. I wish to use the opportunity offered by this CMESG talk to reflect on these truly exciting years spent as a member of the ICMI Executive, and to share some insights and experiences gained from my involvement in the international community of mathematics education in the context of the ICMI programme of actions. It may be particularly timely to venture into such kind of reflections as the Commission has recently celebrated its centennial, a circumstance that offers a most useful framework for such considerations.

My reflections will be largely inspired by the angle I take of a Canadian perspective on such matters. I wish to stress the rich contribution that the Canadian community has already brought to the mission of ICMI and comment on the roles that Canada might continue to play. I also wish to look at some of the main foci of the actions of ICMI over the past decade and see how these can serve to shed light on a possible evolution within the Canadian landscape around matters related to mathematics education. These reflections will touch issues such as the responsibility of "rich" countries as regards the pressing needs in less affluent parts of the world, the perennial difficulty of the mutual understanding and respect between the communities of mathematicians and of mathematics educators, or the structural obstacles encountered in Canada as regards the setting up of a body representing the country in the framework of the ICMI sub-commissions.

This invited lecture is a special feature in the 2010 program to acknowledge and honour Bernard's significant contribution to the international community through his work with ICMI.

Lecture IV: Sandy Dawson[1]

University of Hawai'i

My Journey Across, Through, Over, and Around Academia: "…a Path laid while Walking…"

This is a tale of a chubby prairie kid from very modest beginnings in the north-end of Edmonton (Alberta Avenue) who was inspired, inflamed, encouraged, goaded, prodded, provoked, guided, and more than amply assisted to try new ventures, think new thoughts, seek new experiences, and while doing so build supportive, trusting, and life-long relationships with others whose paths, at least for a time, ran along parallel tracks. This is a story about people building connections, establishing roots (and routes), arguing intensely and going for a pizza-run later, about creating the new by adding to the old thereby changing one's view of the old, about subordinating one's teaching (preaching, telling, advising) to the other's learning (understandings, awarenesses, sensitivities). It is a yarn that, like Haley's Comet returning to a similar area of the universe but one that has undergone evolutionary change, brings the author back to peoples and their ways of knowing and working that depend less on academic study and more on respectful listening and the building of trust so that all may contribute to the laying down of a new path that for a time we can share and tread along together.

This invited lecture is the first of the "CMESG/GCEDM Alumni Lectures". The lecture series is designed to celebrate relationships and reciprocity between the organization's near 40 years of existence, the contributions of its early participants, and the stories that are a part of its fabric.

[1] who at various times is or has been associated with: University of Hawaii, Honolulu; Pacific Resources for Education and Learning; PREL (Honolulu); PME (the World); CMESG/GCEDM (Canada); Simon Fraser University, Vancouver; University of Saskatchewan, Regina; University of Alberta, Edmonton.

WORKING GROUPS

Working Group A *Teaching Mathematics to Special Needs Students*

Leaders: Cathy Bruce, Geneviève Lessard, Laurent Theis

The issue of student learning challenges in mathematics, and the interventions to support students with special needs, is a sensitive and controversial one facing our education systems. Our range of understandings and perspectives with regard to learning difficulties in mathematics has a considerable influence on the decisions that educators make. And these decisions have tremendous impact. Further, the body of research on differentiated instruction and working with special needs students in mathematics tackles this question from a variety of angles and lenses.

Differentiated instruction is one of the commonly cited pedagogical methods for supporting all students, no matter the level of education. Research tells us that students learn differently but the challenges of successfully differentiating instruction are substantial.

In this working group, we will explore the challenges of teaching students with special needs in mathematics classrooms. To begin, we will collectively attempt to gain a deeper grasp of the complexities and multidimensional nature of working with special needs students: Who are they and what kinds of perceptions do we have of these students? What are their specific difficulties in mathematics and how do these difficulties manifest themselves in the classroom? What are the challenges faced by the teacher with this particular population? Might we revisit our conceptions of these students? Is it the teacher who has the difficulties teaching in ways that meet the needs of these students? How do we define success for these students? To explore the above questions we will, among other strategies, engage in examining student work samples from a range of education levels, as case studies.

Then we will discuss pedagogical interventions that seem to enable students with special needs. On what principles could these interventions be based? How are they the same and different than those strategies that have been proven to be effective with students who do not face these learning challenges? How do we prepare educators to effectively engage and support this population of students? Based on these points of discussion, we will draw on the experiences of the facilitators and participants in the working group.

Working Group B *Attending to Data Analysis and Visualizing Data*

Leaders: Veda Abu-Bakare, Linda Gatuso, Georges Monette

Data analysis and visualization of data have become an integral part of the elementary and secondary curricula as well as for pre-service teachers' courses. Not only must we consider how to make these important and relevant topics meaningful to students but a major hurdle to be overcome is that of ensuring that our future teachers have the confidence and knowledge to attend to this strand of the curriculum.

It is important that students of all ages and teachers develop statistical thinking in the manner of a statistician. How can we guarantee that this will occur?

What activities, experiments, simulations, and resources can we use and develop with students and pre-service teachers? In what ways can the technology that is readily available motivate and deepen understanding? How can we use existing indices and databases such as Statistics Canada's

Consumer Price Index, E-Stat and CANSIM to empower our students and pre-service teachers and help them make sense of our data-centric world?

Further, we must consider the fact that this teaching generally takes place within mathematics or mathematics methods courses (in the case of teaching training). How can we promote the synergy of these two disciplines, that of mathematics and that of data analysis while fostering learning? Or moreover, do these two disciplines originate in two distinctive and irreconcilable ways of thinking?

In our group, we will present activities drawn from research articles and share personal experiences so that we may elicit discussions that can shed light on the questions mentioned above. We encourage active and productive participation that we hope will give participants new resources to support them in preparing teachers and in the actual teaching of data analysis and visualization of data. In preparation for this Working Group, please visit: wiki.math.yorku.ca/index.php/CMESG_Working_Group_2010:_Data_Analysis_and_Visualization

Burrill, G. and Elliott, P. (2006). *Thinking and Reasoning with Data and Chance*. NCTM, Reston Virginia.
Tufte, E. (1983). *The Visual Display of Quantitative Information.* Graphics Press, Cheshire, Conn.
Tufte, E. (1990). *Envisioning Information*. Graphics Press, Cheshire, Conn.

Working Group C *Working Group on Recruitment, Attrition and Retention in Post-Secondary Mathematics*

Leaders: Miroslav Lovric, Olivier Turcotte, Walter Whiteley

In the international context, Universities in England are closing departments of Chemistry, and Physics and leaving service teaching to other programs. Under financial pressure, Universities in Canada are also starting to close programs with low enrollment. The key to these decisions seems to be enrollment and graduation rates. Mathematics programs are being judged by recruitment and retention numbers, as well as the quality of the support they provide through service courses. At the least this impacts whether people are hired into mathematics departments. At the extreme – some programs within mathematics departments will be closed, or even whole departments might be closed (as has happened in some Ontario Colleges).

There are a number of causes that have been suggested some of which are observed on an international scale, some of which are local to the cultures of the region or the institutions, some of which connect to student motivation, and the quality of student experiences. A number of responses have been suggested including:

- collaborations with other disciplines, such as education and interdisciplinary science programs;
- offering challenging mathematics in senior secondary education and undergraduate programs;
- refocusing on the balance between topics and processes in the objectives and courses of post-secondary mathematics programs.

We will draw from the research we can collect, from the data and stories brought by participants from their institutions, and from broader recommendations from groups such as the Mathematical Association of America to address these issues. We are hoping that our group will attract participants with a large spectrum of experiences in mathematics.

We will also look at the image of mathematics / preparation for the mathematical sciences in the high schools, as it connects to recruitment. Where the experience of mathematics in the first-

year of post-secondary education very different from the high school image – does this contribute to attrition?

We will investigate how other factors (such as quality of instruction or availability of adequate resources, e.g. good textbooks and good support) influence students' decisions to stay (or not) in mathematics.

Through the three days, we will consider what can be done to recruit and retain students with a strong interest in mathematics either as their major focus, or as part of their broader learning over several disciplines.

In preparation for this Working Group, please visit: www.math.mcmaster.ca/lovric/cmesg.html

Working Group D *Mathematics and Aboriginal Peoples of Canada*

Leaders: Ed Doolittle, Lisa Lunney Borden, Dawn Wiseman

Aboriginal peoples in Canada have long called for the decolonization of education and the incorporation of indigenous knowledge, culture, and values in the curricular and pedagogical practices in both public school and locally controlled schools to support the learning needs of Aboriginal students. More recently, most provinces have enacted a formal requirement for the integration or infusion of Aboriginal perspectives in all curriculum areas, including mathematics. Despite this formal move to integrate Aboriginal perspectives, little substantive change has been made in mathematics education to support these goals. Even when teachers attempt such integration they often find it difficult. They may be unaware of community cultural and linguistic practices from which to build students' mathematical understanding and they may not be familiar with Aboriginal ways of learning and teaching that might help to transform their pedagogical practices. Furthermore, they might grapple with ways to negotiate the space between school-based mathematics and Aboriginal ways of reasoning about things seen as mathematical. This group will examine the tensions between these two seemingly incompatible worldviews through questions such as the following:

- What do teachers need to know to better understand these tensions?
- How might mathematics education for Aboriginal students be supported / transformed by an increased understanding of Aboriginal languages, cultures, histories, etc.?
- What role should Aboriginal communities have in setting the goals of math education particularly in provincial/ territorial curricula, and what processes might we use to translate non-specialist conversations about general social goals and desires to specialist instructions/processes for mathematics education?
- What are the community-defined needs that would require solid math education /preparation? How are these needs being addressed?
- Where/how is/has math, or mathematical reasoning, (been) used in community? What practices does it support? How might this existing knowledge provide insight into ways in which mathematical concepts can be pulled in to community knowledge?
- What are indigenous epistemologies? How might they inform mathematics education? What are the pedagogical implications of such epistemologies?

Through our discussions we hope to gain an increased awareness of the complexities of this issue and develop new insights into potential avenues of research and professional development that can be used to support mathematics educators in as they continue on this journey.

In preparation for this Working Group, please visit: www.math.uregina.ca/~doolittl/cmesg/

Working Group E *Elegance and Beauty in Applied Mathematics*

Leaders: France Caron, Leo Jonker

Mathematics is often described – and regularly defended – as being both beautiful and useful. Yet, there is a general tendency to associate beauty and elegance with pure mathematics, and usefulness with applied mathematics. Early 20th century mathematicians like Russell and Hardy contributed to this view. Thus Russell described the beauty of mathematics as "cold and austere" and "remote even from the pitiful facts of nature". But is it really possible, or desirable, to separate beauty and usefulness in this way? Again and again we learn that "pure" mathematical discoveries motivated solely by curiosity and elegance turn out to be essential to modern technological advances as well as to entire branches of science (e.g. modern physics). Is there not beauty in the surprise, and elegance in the way, that mathematics "fits" these applications? Do the search for a mathematical model to fit a problem, and the collaboration around that search, not participate in beauty also? Speaking of "pure" mathematics, Gowers (see the reference below) located mathematical beauty in the tension between a complex situation and a simple explanation. Should not the same apply when a much more complex "real world" problem is addressed by a simple mathematical model?

In modern aesthetics, close attention to the social context and cognitive aspects of art has diminished the role of beauty. Should there be a similar re-assessment of the place of beauty, or the meaning of beauty, in the aesthetics of mathematics? What would that mean, especially for our pedagogy? How is teaching itself an aesthetic activity?

Participants in this working group are encouraged to bring applications of mathematics that they find particularly beautiful or elegant, and to indicate how they might incorporate these applications in their classrooms. Examples from all levels of education are welcome. Exploring these, we will discuss how applying mathematics in the classroom can engender an awareness of mathematics' beauty, and whether and where an emphasis on applications may diminish the appeal of the subject. We hope that our reflections will contribute to the reconciliation of the pure and applied sides of mathematics by capturing their common aesthetic drive and recognizing them as different expressions of one art.

Blum, W., Galbraith, P.L., Henn, H.-W. & Niss, M. (Eds.) (2007) *Modelling and Applications in Mathematics Education*. The 14th ICMI Study Series: New ICMI Study Series. New York, NY: Springer.

Caron, F. (2006) Mathématiques et poésie: À la recherche de l'idéal, *Accromath*, Volume 1, Summer – Fall 2006.

Gowers, T. (2000) *The Importance of Mathematics*. Lecture at the Clay Mathematics Institute Millennium Meeting. Paris, May 24, 2000.

Jonker, L. (2004) *Mathematics and Beauty: Kieran Egan's kinds of understanding as a filter for identifying manifestations of beauty in the study of mathematics*. Paper presented at the 2004 International Conference on Imagination and Education.

Sinclair, N., Pimm, D. & Higginson, W. (Eds.). (2006). *Mathematics and the Aesthetic: New Approaches to an Ancient Affinity*. New York, NY: Springer.

Steiner, M. (1998), *The Applicability of Mathematics as a Philosophical Problem*, Harvard University Press, Cambridge Massachusetts.

Working Group F *Noticing and Engaging the Mathematicians in our Classrooms*

Leaders: Egan J Chernoff, Eva Knoll, Ami Mamolo

Many characteristics describe the work of a mathematician. These characteristics just as readily apply to the work of 'professional' mathematicians – e.g. people who 'do math' as a career,

researching and publishing in the field – as they do to 'amateur' mathematicians – e.g. people who 'do math' without funding, be it students, teachers, or teacher educators. The focus of this working group will be to explore different ways in which teachers, mathematics educators, and (professional) mathematicians come to appreciate themselves and their students as mathematicians.

Through engagement with mathematical tasks, our working group will establish a sense of what it means to 'be a mathematician'. This will develop from a shared vision of fundamental aspects of 'doing math' that are exemplified in the tasks, discussions and experiences of our group members. Specific questions will help shape our discussions:

How is it that teachers/teacher educators/mathematicians come to notice and foster mathematical thinking in primary, secondary, and tertiary classrooms? This question is motivated by Wheeler's concern that "the majority of teachers [do] not encourage their students to 'function like a mathematician'" (Wheeler, 1982, p.46).

How can we as teachers engage students as mathematicians and what types of tasks model what it is that mathematicians 'do'? This question is motivated by a recognized disconnect between how students experience mathematics in the classroom and how professional mathematicians experience mathematics in research (e.g. Boaler, 2008; Lockhart, 2009).

Boaler, J. (2008). *What's Math Got to Do with It? Helping Children Learn to Love Their Most Hated Subject – And Why It's Important for America*. New York: Viking Penguin.

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TOPIC SESSIONS

Topic Session A *Dynamic Number*

Leader: Nathalie Sinclair and Nick Jackiw

In the classical quadrivium continuous and discrete mathematics appear in both static and dynamic forms. A millennium later, the static forms (geometry and arithmetic) are familiar and entrenched; the dynamic forms (astronomy and music) are esoteric where not completely purged from our conception of mathematics. Yet technology mediates both mathematics and perception. Through contemporary technology the terms of the quadrivium re-enter flux. Specifically, Dynamic Geometry Software gives us a discourse in which geometriesand not just planets appear in motion, thereby collapsing one of the quadrivium's central oppositions. If so goes geometry, whither arithmetic? This provocation inspires the central questions of our topic group: what are the possibilities for re-conceptualising number and arithmetic as dynamic number and dynamic arithmetic? And what are the technological affordances of such a vision, and their potential impacts on mathematics, and on perception?

Topic Session B *Doing, Feeling, Thinking Mathematics… in Teacher Preparation*

Leader: Frédéric Gourdeau

As I am writing this summary for the topic session, I am having difficulty. I have a goal, but it is too wide and hardly well-defined: to engage with you in a topic session that will enable us to share a common understanding of the mathematical courses for students enrolled in the undergraduate degree for secondary mathematics education at Université Laval. It is a long sentence… and it is not very clear.

I will definitely present some activities and topics which form part of those mathematics courses, but I will mostly try to explore with you the reasons behind the choices made, the idealism behind some of the attempted activities, the complexity of what we are looking at when thinking about education of/for mathematics teachers. This is for CMESG, and it is through this group and inspired by the work of so many of its members, that I have developed some personal reflection about all this. I hope the topic session will become part of a conversation which started many years ago for me at CMESG, and still continues.

NEW PHD SESSIONS

Souleymane Barry ***Analysis of the Resources Used by a Teacher and a Researcher while Designing Teaching Scenarios in Combinatorics to Develop Modelling Skills in Secondary I (Grade 7)***

From within a collaborative approach for the design of teaching scenarios in combinatorics aimed at developing modelling skills in Secondary I (Grade 7), we have tried to document contributions made by both a researcher and a teacher through: the designed combinatorics problems they designed, the modelling process developed by students as they worked on and made use of these problems, and the teaching aimed at developing this process. Our analysis brought to the fore several resources upon which both the teacher and researcher drew. The resources that we illustrate in this presentation are of two kinds: interpretive resources and action resources. In both cases they borrow from the frames of reference of the teacher and researcher. Our study also highlighted promising characteristics to include in combinatorics problems aimed at introducing/developing modelling and at identifying support/exchange (communication) routines to establish/maintain, in order to develop a modelling culture within the classroom. Last but not least, this doctoral research broadens the notion of interpretive resources as it is understood in experiential sociology.

Mary Beisiegel ***Being (Almost) a Mathematician: Teacher Identity Formation in Post-Secondary Mathematics***

The purpose of this research project was to uncover issues and difficulties that come into play as mathematics graduate students develop their views of their roles as university teachers of mathematics. Over a six-month period, conversations were held with mathematics graduate students exploring their experiences and perspectives of mathematics teaching. Using hermeneutic inquiry and thematic analysis, the conversations were analysed and interpreted with attention to themes and experiences that had the potential to influence the graduate students' ideas about and approaches to teaching. There were several experiences and perspectives that the mathematics graduate students voiced as having an influence on their teaching practices. These included observable structures, such as their teaching assistant duties and the physical spaces in which they worked. Some of the influences on their teaching were not as tangible, however, such as their views on the role of a professor. The graduate students did not appear have a forum or support network to assist them in understanding their experiences. In their attempts to make sense of these issues without guidance, many of their pre-existing notions about learning mathematics and their new experiences as teaching assistants had a significant influence on their views of teaching.

Aldona Businskas ***Conversations about Connections: How Secondary Mathematics Teachers Conceptualize and Contend with Mathematical Connections***

The importance of mathematical connections in learning and understanding mathematics is widely endorsed in both the research and the professional literature but teachers' understanding of mathematical connections is underexplored. This study examined teachers' conceptions of mathematical connections as knowledge at the interface of content knowledge and pedagogical content knowledge. Teachers' explicit connections related to particular mathematical topics were

examined in a three-stage process of progressively more structured interviews with nine secondary mathematics teachers. Five types of connections were identified – different representations, implications, part-whole relationships, procedures, and instruction-oriented connections. Teachers were enthusiastic in their approval of considering mathematics as an interconnected web of concepts but reported that they rarely pointed out mathematical connections in their teaching.

Egan J Chernoff ***Subjective Probabilities Derived from the Perceived Randomness of Sequences of Outcomes***

This research continues the longstanding tradition of taking an interdisciplinary approach to studies in probability education. Respondents, prospective elementary and secondary school mathematics teachers, are presented with sequences of heads and tails derived from flipping a fair coin five times and asked to consider their chances of occurrence. A new iteration of the comparative likelihood task, which maintains the ratio of heads to tails in all of the sequences presented, provides unique insight into individuals' perceptions of randomness and associated probabilities. Further, this research will demonstrate how unconventional interpretations of the sample space – organized according to switches, longest run, and switches and longest run, which are all based upon individuals' verbal descriptions of the sample space – can situate individuals' answers and justifications within conventional probability. In order to do so, an original theoretical framework, entitled the *meta-sample-space*, will be used with a new method, entitled *event-description-alignment*, to demonstrate, for the first time, that individuals' probabilities, derived from the perceived randomness of sequences of outcomes, are in accord with or model a *subjective-sample-space*, which is partitioned according to an individuals' interpretation of the sequence of outcomes they are presented. Consequently, it will be shown, amongst other results, that conventionally incorrect responses to the task are not, necessarily, devoid of correct probabilistic reasoning.

Krista Francis-Poscente ***Learning to Play with Mathematics Online***

Learning to Play with Mathematics Online is a hermeneutic study about an online professional development program for K-12 mathematics teachers. I invited 10 teachers, a mathematics educator and a mathematician to explore mathematical problem solving in Elluminate™: a synchronous online environment. In four sessions we learned how to overcome technological obstacles to invoke mathematical play. Importantly, we found that mathematical problems that: (1) focus on concepts and connections across mathematical ideas; and (2) require easily drawn representations for demonstrating solution strategies, worked well in our online mathematical play environment. In this presentation I will share insights gained from our experiences.

Nadia Hardy ***Students' Models of the Knowledge to be Learned about Limits in College Level Calculus Courses. The Influence of Routine Tasks and the Role Played by Institutional Norms***

In this talk I present a study of instructors' and students' perceptions of the knowledge to be learned about limits of functions in a college level Calculus course, taught in a North American college institution. I have modeled these perceptions using a theoretical framework, which combines elements of the Anthropological Theory of Didactics, developed in mathematics education, with a framework for the study of institutions – the Institutional Analysis and

Development framework – developed in political science. I describe the models and illustrate them with examples from the empirical data, on which they have been built: final examinations from the past six years (2001-2007), used in the studied College institution, and specially designed interviews with 28 students. While a model of the instructors' perceptions could be formulated mostly in mathematical terms, a model of the students' perceptions had to include an eclectic mixture of mathematical, social, cognitive and didactic norms. The analysis that I carry out shows that these students' perceptions have their source in the institutional emphasis on routine tasks and on the norms that regulate the institutional practices.

Elizabeth Mowat ***Making Connections: Network Theory, Embodied Mathematics, and Mathematical Understanding***

In this dissertation, I propose that network theory offers a novel and productive way to interpret mathematical understanding. A network model is used to analyze connections among mathematical concepts, focusing in particular on their embodied nature and reliance on metaphor. After an investigation of the network of metaphors that underlies mathematics, the topology and dynamics of this scale-free structure are examined. A discussion of the effect these characteristics have on comprehension of mathematics and mathematical pedagogy follows. To substantiate ideas presented in this work, I explore part of the proposed metaphoric network linked to the concept of EXPONENTIATION. Results suggest that viewing mathematical understanding as a complex network is both instructive and important.

Mary M. Stordy ***Recovering Mathematics: An Ontological Turn toward Coming to Understand the Teaching of Mathematics with Children***

Recovering Mathematics: An Ontological Turn Toward Coming to Understand the Teaching of Mathematics with Children is an interpretive study into the teaching of mathematics to children. Drawing from Gadamer's (1989) ontological hermeneutics, this research examines lived experience through narrative pedagogic events to explore the idea of recovering mathematics as a living human enterprise for children and teachers in schools. Attending to Caputo's (1987) idea of returning to the original difficulty, the text attempts to keep the difficulty of teaching alive while resisting the metaphysics of presence. In Truth and Method (1989), Gadamer claims that the happening of events is essential for understanding. This philosophical inquiry embraces Gadamer's idea of "the fecundity of the individual case" as a way to explore and make meaning from lived experiences with children, teachers, and primary / elementary pre- service teachers. Recovering Mathematics hermeneutically considers the relationship of mathematics to teaching in terms of the past and the present, the particular and the general, the philosophical and the practical, the part and the whole. It is a philosophical exploration into what might be possible when it comes to teaching mathematics to children when the world, which includes the living world of mathematics, is allowed entry.