Technology Use in Post-Secondary Mathematics Instruction
Utilisation de la technologie dans l'enseignement mathématique post-secondaire
(Org: **Chantal Buteau** (Brock), **Daniel Jarvis** (Nipissing) and/et **Zsolt Lavicza** (Cambridge, UK))

PETER ADAMIC, Laurentian University, 935 Ramsey Lake Road, Sudbury, Ontario, P3E 2C6
The pedagogical importance of statistical simulation methods

Statistical theory and methods are employed in virtually every academic discipline when data needs to be analyzed. Indeed, required courses in statistics are currently the norm in most quantitative fields. The advantages of using computer technology to achieve fast and accurate statistical results, and their need in statistical education, are both well established. However, the pedagogical uses of statistical simulation methods do not, at present, hold a firm foundation in post-secondary statistical curriculum, especially at the introductory level. The advantages of employing such methods are crucial for the modern user of statistical methodology, and can be appropriated on many different levels. First, simulation techniques are very useful in presenting key statistical concepts. For example, the Central Limit Theorem, probability density functions, asymptotic consistency, and even confidence limits all become far more intelligible when the student is shown how these results actually operate in practice.

Secondly, it is certainly the case that there are many real-world problems that simply cannot be solved using conventional theoretical models. For example, deriving standard errors for various estimators using re-sampling methods (such as the Bootstrap or Monte Carlo methods) are necessary in a wide variety of applications, especially for the more complicated multivariate problems.

Finally, it is quite easy to implement simulation methods in class or on assignments, and these methods are typically present in all of the main statistical software packages (e.g. SAS, S-PLUS, MINITAB, SPSS, etc.).

ROBERT BILLINSKI, Collège Montmorency
Different approach to computer labs

What is the objective of a computer lab? How proficient does a student need to be to "perform"? What is the student learning: math, computer usage skills, software...? This talk will not have all the answers but will have some down-to-earth analysis to propose. A handful of actual examples of computer labs will be used to illustrate the variety of approaches possible and the range of objectives that labs seem to be able to have.

CHANTAL BUTEAU, Brock University, Canada
Triggering University Students' Mathematical Creativity and Intellectual Independence by Use of Technology

In this presentation I will discuss university students' mathematical creativity and intellectual independence triggered through a specific use of technology, that is the design and implementation of mathematics Exploratory Objects: digital, interactive, easy to use, and exploration plate-form that are designed to explore a mathematics conjecture, problem or application. My reflection takes place in the context of the Mathematics Integrated with Computers and Applications (MICA) core undergraduate program launched at Brock University in 2001. Two main program principles are

(1) encouraging student creativity and intellectual independence, and

(2) developing mathematical concepts hand in hand with computers and applications.

In addition to the revision of all traditional courses (e.g. Analysis, Algebra, etc.), three unique MICA I, II, and III courses were developed as a concrete implementation of these two principles. It is in these courses that students learn to design,

implement and use mathematics Exploratory Objects, including original final projects on a topic of their own choice (see `www.brocku.ca/mathematics/studentprojects`). I will conclude the presentation by briefly discussing how some students continue, beyond the MICA courses, to design Exploratory Objects.

FRANCE CARON & KATHLEEN PINEAU, Université de Montréal; École de Technologie Supérieure, Montréal
Rethinking representation registers and communication when teaching mathematics with symbolic calculators

The possibility of easily combining numerical, graphical and symbolic representations has contributed to legitimise the use of symbolic calculators in the teaching of mathematics. Professors who integrate these tools in their teaching recognize the value of multiple representations for supporting conceptual understanding. Yet, when it comes to problem solving by students, some of these teachers set up mechanisms that impede the use of registers other than the symbolic, or that result in the masking of technical work done with the tool in written solutions.

Based on examples taken from the first calculus course at École de technologie supérieure, we will present situations which illustrate and explain some of the tensions and paradoxes that are generated by the introduction of symbolic calculators in mathematics classes. We will then propose strategies which make it possible to move beyond these oppositions towards a greater control in the development of an instrumented mathematical practice.

PHILIPPE ETCHECOPAR & JEAN-PHILIPPE VILLENEUVE, Cégep de Rimouski, Rimouski, QC
Modelling-Simulating Method of Problem Solving and Its Impacts

We have developed, some ten years ago, at the Cégep de Rimouski a method of problem solving that we called the Modelling-Simulating Method. This method is used with Maple (a computer algebra system) and it enables the students to solve problems of applied mathematics, like "real life" problems, problems in physics, in biology or problems related to some environmental issues. The central aspect of that method is to understand a problem by numerical or graph simulations. So, it is possible to follow the evolution of the modeled phenomena, to identify the role of its parameters or some special cases and also to find some limitations of the mathematical model. We will give an example of the application of that method to solve a particular problem.

The choice of teaching applied mathematics has been made because most of our students go to health and applied science. That choice and the use of the Modelling-Simulating method and of Maple raise some important issues: the possible changes of the mathematics curriculum, the interdisciplinary approach, the use of technology in mathematics courses, the development of a critical attitude and of a scientific culture, etc.

D. JARVIS, C. BUTEAU, Z. LAVICZA & N. MARSHALL, Nipissing University; Brock University; University of Cambridge (UK); Brock University
Issues surrounding technology integration in university education: results of a literature review

In this session we will present preliminary results of a literature review pilot study regarding the use of Computer Algebra Systems in post-secondary education. This study is part of an international research project (2007–09). Based on the pilot study results (summer 2008), we will highlight several emergent issues surrounding technology integration in university mathematics instruction. Our findings suggest that the multi-dimensional theoretical framework proposed by Lagrange et al. (2003) for literature review on technology in mathematics education requires certain modifications for our focus on systemic technology integration in post-secondary education.

MARGARITA KONDRATIEVA & OANA RADU, Memorial University, St. John's, Newfoundland, A1C 5S7
Learning precalculus with an interactive computer-based technology

Exposition to advanced mathematical thinking makes the ability to follow logic of a derivation and interpret formal content crucial for university students' success. Use of an interactive computer-based technology may assist the learners in extending

from concrete to abstract thinking while improving their basic skills of doing routine mathematics accurately and efficiently. Experimenting and immediate feedback allow re-thinking of the fundamental concepts and validation of the action.

The development of new instructional media for introductory mathematics courses at Memorial University is a response to changing instructional setting and the call for improvement of students' understanding. Our online laboratory offered additional practice to 155 students studying pre-calculus in 2007. By solving online exercises and quizzes, sharing ideas and experiences, students built knowledge and confidence necessary for success. Besides that, the instructional media allows the instructor to monitor students' progress, also measured by paper tests, and record the changes in the students' motivation, perception, and interest in mathematics.

Along with a number of positive outcomes observed at the current stage of the project we would like to address several issues which include students' attitude towards computer-assisted learning, balancing workload and the assessment between computer based and traditional paper-and-pencil approach, and smooth merging of in-class and homework practice.

More details can be found in a short report submitted by the authors in *Making the Grade, v. 3: A compendium of data-driven case studies on the effectiveness of MyMathLab and MathXL* (M. D. Speckler, ed.) Pearson Education, 2009, pp. 22–23.

ZSOLT LAVICZA, University of Cambridge, 184 Hills Road, Cambridge, CB2 8PQ, UK
Mathematicians' conceptions of technology use in university-level mathematics teaching

Digital technologies are becoming an integral part of everyday life and are increasingly used at all levels of education. Anecdotal evidence suggests an increase in the use of technology, particularly Computer Algebra Systems (CAS), for the teaching and learning mathematics at universities. However, little is known about the current extent of CAS use in university-level teaching, the various practices mathematicians apply when teaching with technology, and mathematicians' views on the role of CAS in teaching mathematics. In my talk, I will outline results of a two-phase international comparative survey study, carried out in Hungary, the United Kingdom and United States, that examined

(1) the extent of CAS use in;

(2) the factors influencing CAS integration into; and

(3) the effects of different teaching traditions on university-level CAS-assisted mathematics teaching.

Results indicated that that many mathematicians extensively use CAS in their teaching and research.

According to the developed statistical models, the teaching use of CAS was significantly influenced by mathematicians' CAS use in their own research and was largely affected by mathematicians' conceptions of the role of CAS in mathematical literacy. However, despite the substantial differences in teaching traditions in the participating countries the study did not reveal considerable differences in mathematicians' use and conceptions of CAS in their teaching between the participating countries.

PANEL DISCUSSION, with France Caron (Université de Montéal), Zsolt Lavicza (University of Cambridge, UK), Yvan Saint-Aubin (Université de Montréal), and Keith Taylor (Dalhousie University)
Can we still teach university mathematics without the use of technology in mathematics instruction?

The recent International Congress on Mathematical Education 11 conference (Mexico, July 2008) showed concerns about the international trend of disinterest in university mathematics. Departments of mathematics have a responsibility of questioning the current curriculum. But should that involve consideration of the role and relevance of technology within the 21st-century mathematics curriculum? Has technology reshaped our teaching of mathematics at university? How can the use of mathematics technology and software support students' learning of mathematics? How does it affect curriculum and assessment? What are the drawbacks and the potential benefits of the integration of these technologies? Four panelists, France Caron (Université de Montréal), Zsolt Lavicza (University of Cambridge, UK), Yvan Saint-Aubin (Université de Montéal), and Keith Taylor (Dalhousie University) will share their view on these questions. Attendees will be invited to participate in the discussion.

YVAN SAINT-AUBIN, Université de Montréal, CP 6128 Centre-ville, Montréal
Animations in mathematics: cost and impact

Many mathematical concepts, even very abstract ones, can be represented efficiently with figures. Nonetheless, historically, there has been significant reluctance to use figures to convey intuition in mathematics. This uneasiness might be philosophical. But it might also stem from the historical lack of tools (difficulty in producing good mathematical drawings) or from ignorance (of current computer tools). Recently the possibility of doing animations has become very real. I will review the time cost of preparing these and their impact in the classroom. (And I'll show you some!)

JACK WEINER & JEREMY BALKA, University of Guelph, Guelph, Ontario, N1G 2W1
Implementing and Evaluating Maple in the Classroom and Maple TA Online Testing in First Year Calculus

At the University of Guelph, we have been incorporating Maple in honours first year calculus to help us mathematically explore, visualize, verify, and sometimes just to have mathematical fun. Beyond the classroom, we have designed completely algorithmic Maple Testing and Assessment test banks for every week of the course.

In the first part of the talk, Jack Weiner will show how Maple has taken usually difficult topics like Volumes of Revolution and brought them to life. He will also show how effectively TA tests can ensure mastery of the fundamental learning objectives of the course.

Then Jeremy Balka will discuss some problems encountered when trying to evaluate the effectiveness of these methods along with some preliminary statistical results.

A web address will be provided so that interested participants can download files of the class notes and the TA test banks.