Assessment in mathematics courses integrating technology

Technical/pedagogical challenges and curricular considerations

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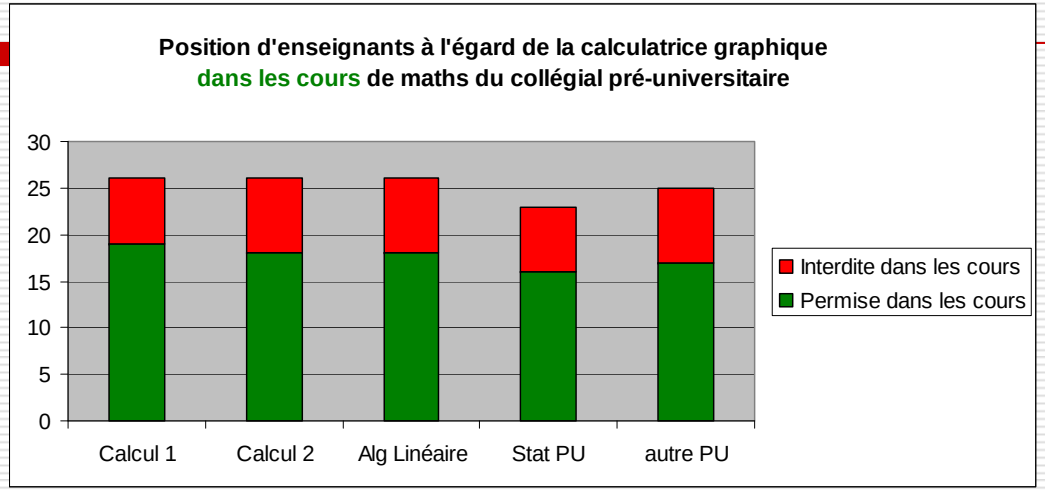
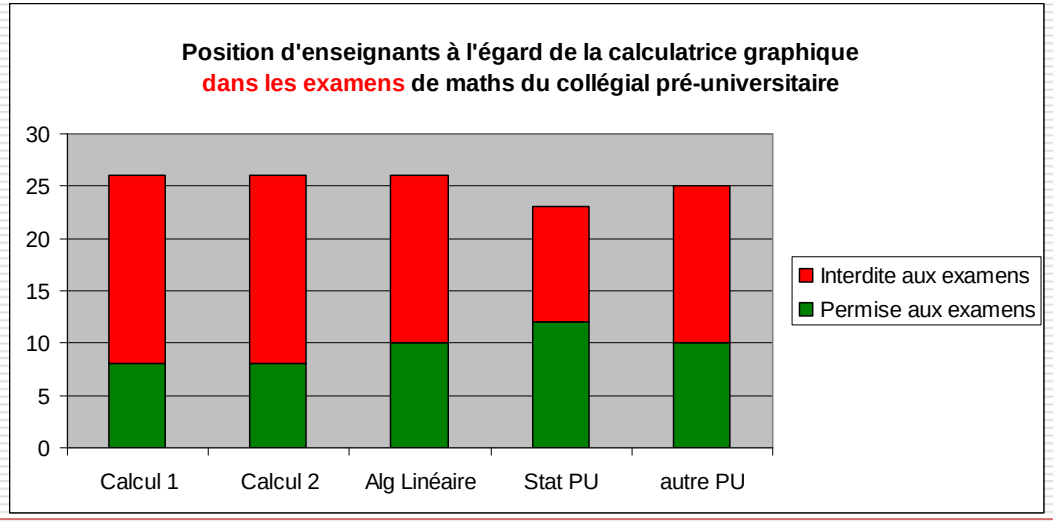
The case of graphing calculators in cegep courses





Compilation sur l'utilisation des calculatrices dans les cours de mathématiques au niveau collégial. AMQ, 2008.

In courses where technology is used, is it also part of the assessment tasks?

If so, where?	*Type of assessment*		
Format	**(Self) Diagnostic**	**Formative**	**Summative**
Quiz			
Exam			
Homework			
Lab report			
Project			
Journal			
Portfolio			
Forum			
Other			

What is the role of technology in the assessment tasks?

	Type of assessment		
Role	**Diagnostic**	**Formative**	**Summative**
Answer recording			
Equation editing			
Validation/verification			
Illustration/visualisation			
Exploration/simulation			
Symbolic computation			
Numerical computation			
Communication			
Collaboration			

Use of technology in assessment in mathematics courses

- If access to technology is accepted in assessment tasks:
  - Difficulty of ensuring fairness and honesty in exams/tasks that incorporate technology.
- If it is not:
  - MESSAGE SENT… AND RECEIVED:
    Development of a mathematical practice that makes pertinent use of technology :

    NOT a learning goal recognized by the institution.

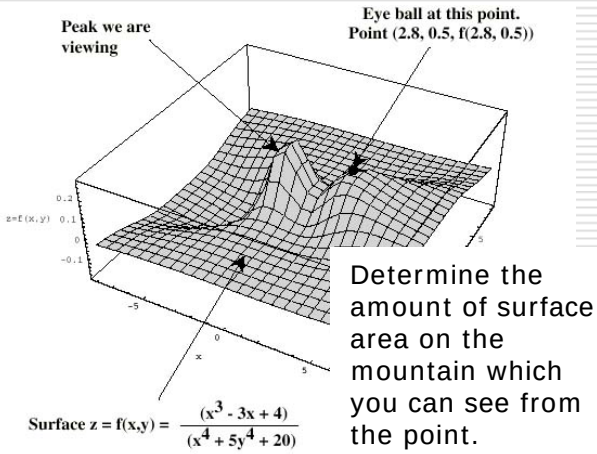
A Case of Formative Assessment with Technology

- Complex, technology-based problems worked in groups during class, possibly over a period of several days
- Perceived as suitable environment for assessment of
  - initiative, creativity, and discovery;
  - communication, flexibility and tolerance;
  - follow-through, rigor, and communication;
  - growth and understanding in mathematics;
  - self-assessment skills.
- For the teacher
  - Instant feedback.
  - Demanding and delicate coaching.
- For this to work:
  - The problem to solve has to be interesting enough.
  - Class size should be about 24 students = 8 groups of 3.

Through the interactions

Journal recording process

Writing of a final report



B. J. Winkel (1999) Formative Assessment During Complex, Problem-Solving, Group Work in Class, *in* MAA Notes 49 - *Assessment Practices in Undergraduate Mathematics*

Assessment as driven by institutional goals

- USMA Educational Goal:

  Enable its graduates to anticipate and to respond effectively to the uncertainties of a changing technological, social, political, and economic world.

- Pedagogical shift in the Dept of Mathematical Sciences:

  From teaching mathematics to teaching mathematical modelling, problem solving, and critical thinking

- Curriculum and assessment strategies:
  - *Projects:* in-class problem solving labs
  - *Two-day Exams*:
    - without (day 1) and with (day 2) technology
    - with a situation to reflect upon between the two days.
  - *Modeling and Inquiry Problems*
  - *Electronic Portfolio:*
    - to explore mathematical concepts and their properties
    - to construct and organize relationships between concepts

A. Heidenberg and M. Huber (2006) Assessing the Use of Technology and Using Technology to Assess, in *Supporting Assessment in Undergraduate Mathematics*. MAA.

Tensions in assessment: between…

- what is practical VS what is effective
- ways of knowing in very different disciplines (mathematics VS educational practice)
- a culture of evidence VS a culture of anecdotal experience
- getting by with minimal work for minimal payoff VS probing deeply to expose possibly intractable problems
- individual faculty member's academic freedom VS the larger interest of programs
- testing what students know VS testing for what students can do

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- perceived rigor of symbolic manipulation VS epistemic/pragmatic value of other registers (graphical, numerical, verbal)

(Caron & Pineault, 2008)

B. L. Madison (2006) *Tensions and Tethers: Assessing Learning in Undergraduate Mathematics* in *Supporting Assessment in Undergraduate Mathematics*. MAA.

Untying tethers in a tradition-bound environment

- Practices in program evaluations
  - e.g. number of students rather than learning outcomes
- Faculty rewards system
  - rarely recognizes educational or empirical research
- Lecture-style teaching
  - large classes limit options for formative assessment
- In-course testing
  - rather than a program approach
- Learning goals expressed in terms of content
  - assessment expected to address knowledge of this content
  - consequent resistance to less specific assessment items

B. L. Madison (2006) *Tensions and Tethers: Assessing Learning in Undergraduate Mathematics* in *Supporting Assessment in Undergraduate Mathematics*. MAA.

Some didactical issues with the use of technology in learning mathematics

- Fishing behaviour and other bypasses of the task (Artigue, 1997)
- Perceived disappearance of the necessity of validating or proving
- Time devoted to learning the tool
- Discrepancies between mathematical knowledge and its computational transposition into a computer (Balacheff, 1994)
- Use of black boxes (Buchberger, 1989; Drijvers, 2000)
- The “Jourdain effect” (Brousseau, 1997; Winsløw, 2003)
- Impossible split between technical and conceptual (Lagrange, 2000)
- Loss of information and structure in students’ productions (Cannon & Madison, 2003; Ball & Stacey, 2003)

Instead of trying to teach{mathematics} with technology, could we consider teaching {mathematics with technology}?

Some questions asked by other departments & graduate programs

- Do students in introductory mathematics courses gain the kind of experience in modeling and communication skills needed to succeed in other disciplines?
- Do they develop the kind of balance between computational skills and conceptual understanding appropriate for their long-term needs?

(Ganter & Barker, 2004)

- Are students encouraged (better still, required) to engage mathematics actively in ways other than through routine problem sets?
- Do mathematics courses leave students feeling empowered, informed, and responsible for using mathematics as a tool in their lives?

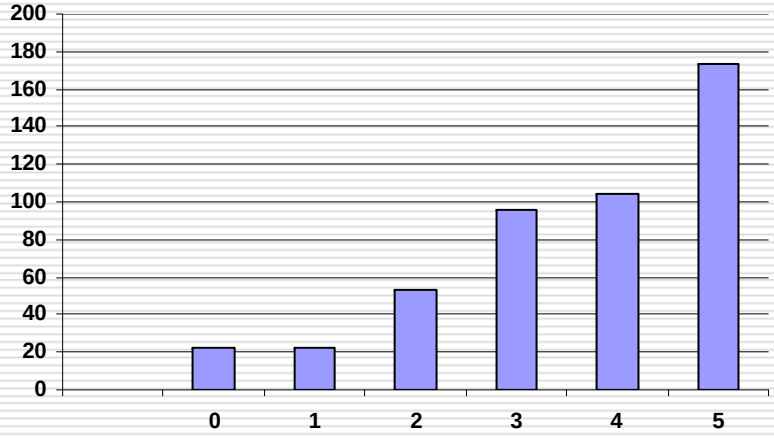
(Ramaley, 2003)

L. A. Steen (2006) *Asking the Right Questions* in *Supporting Assessment in Undergraduate Mathematics*. MAA.

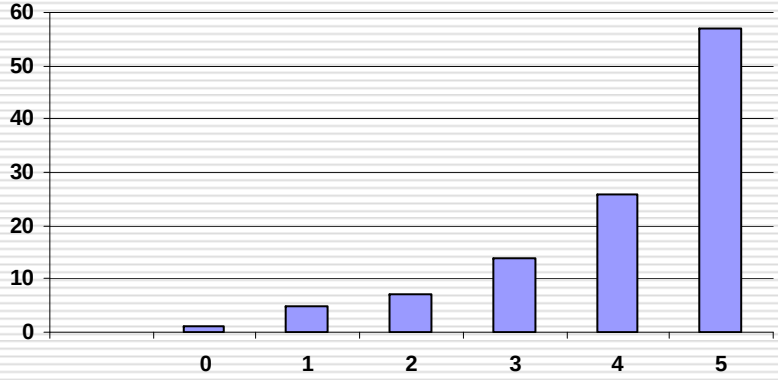
Review of MICA's 1st Cohort (BrockU, 2006)

Do you value the use of technology as a learning tool?
0 = Not at all 5 = A lot

Aggregate of all courses



Students considering graduate studies



Students express their opinion.

Rethinking assessment

Evaluation is a double edged sword.

- When we evaluate our students they evaluate us. For, what we chose to evaluate shows them what it is we value.
- **COROLLARY:** If we, as teachers, value something then we should find a way to evaluate it.

Defining goals in terms of learning outcomes

- When students graduate from a (or your) math program, what activity that is observable do you think (or wish) that they should be able to do?
- What would be the role of technology in that context?
- How could we assess this in the program?
- What tethers should we start untying?

Diagnostic assessment

- Performed prior to new learning
- Functions:
  - Determine what students know about the notion about to be taught
  - Establish the different student levels
  - Derive course orientations based on students' answers
  - Provide a benchmark to assess progress

Formative assessment

- Used in the course of learning
- Functions:
  - For the student : to indicate
    - milestones that have been reached
    - difficulties to be overcome
  - For the teacher :
    - To indicate
      - how the teaching program is achieving its goals,
      - obstacles that may impede progress.
    - To help
      - find source of errors and remediate,
      - adapt didactical/pedagogical interventions to the learning occurring in the classroom.

Sommative assessment

- Used at the end of learning
- Review
  - if objectives have been met
  - in terms of
    - results
    - acquisitions
    - progress