Rapport du sondage Canadien (2009) sur l'intégration de logiciel de calcul formel (LCF) dans l'enseignement post-secondaire des mathématiques

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Research Program

(Jarvis, Buteau, Lavicza: SSHRC 2007-10)

- International studies have shown that Computer Algebra System (CAS)-based instruction has the potential to positively affect the teaching and learning of mathematics

  But: This has not been widely realized in schools and institutions (Artigue, 2002; Lavicza, 2006; Pierce & Stacey, 2004)

  Our long-term objective: To document university teaching practices involving technology and formulate recommendations for individual and departmental change

- Large body of research at school level

  But: Lack of parallel research at the tertiary level

  Our long-term objective: To promote research in tertiary mathematics teaching and strategies for the integration of technology in the university mathematics classroom

Social Sciences and Humanities Research Council of Canada
Conseil de recherches en sciences humaines du Canada
Canada

2007-10 Research Project

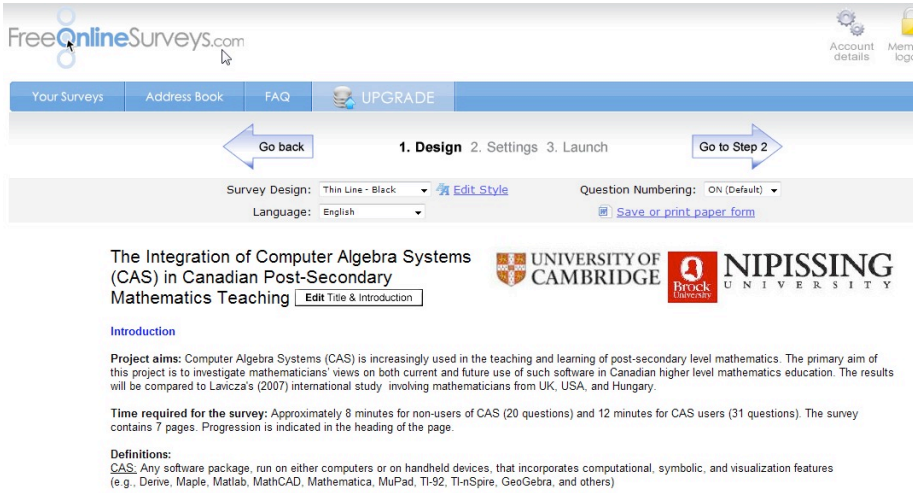
- Comprehensive **literature review**
- **Case studies** of two mathematics departments which have sustained technology-related instructional change over time
- Nation-wide, on-line **survey** of Canadian mathematics professors about their teaching practices

(Analysis in progress)

On-line Web Survey about Canadian Practices
(March - May 2009)

Aim: conduct the survey study in Canada and compare the results with Lavicza's (2008) international survey (USA, UK, HUN); thus

- similar participant recruitment
- similar questionnaire
- same analytical tools



Development of the questionnaire

- Incorporate findings from a qualitative study

  (22 mathematician interviews, class observations, collection of course material in USA, UK, HUN)
- Relate concepts to literature
- Mathematicians' conceptions
- Response rate worries
  - Keep the questionnaire relatively short
  - Develop closed questionnaire items (difficult to obtain responses for open items)
  - Obtain adequate information from closed items
- Adapt questionnaire to Canadian reality:
  - Quebec cégeps
  - English and French versions (translation)

* Lavicza (2008) Canadian survey

Questionnaire structure

- Personal characteristics
- Mathematicians' views on the role of CAS in mathematics literacy
- Mathematicians' views on CAS-assisted teaching and learning
- Mathematicians' views on factors hindering CAS integration into teaching learning of mathematics
- Actual use of CAS in mathematics teaching
  - (30 questions, several (8-12) sub-questions)
  - 10-12 minute completion time
- Actual use of any 'mathematics technology' in research and mathematics teaching
  - (32 questions)

* Lavicza (2008) Canadian survey

Received data

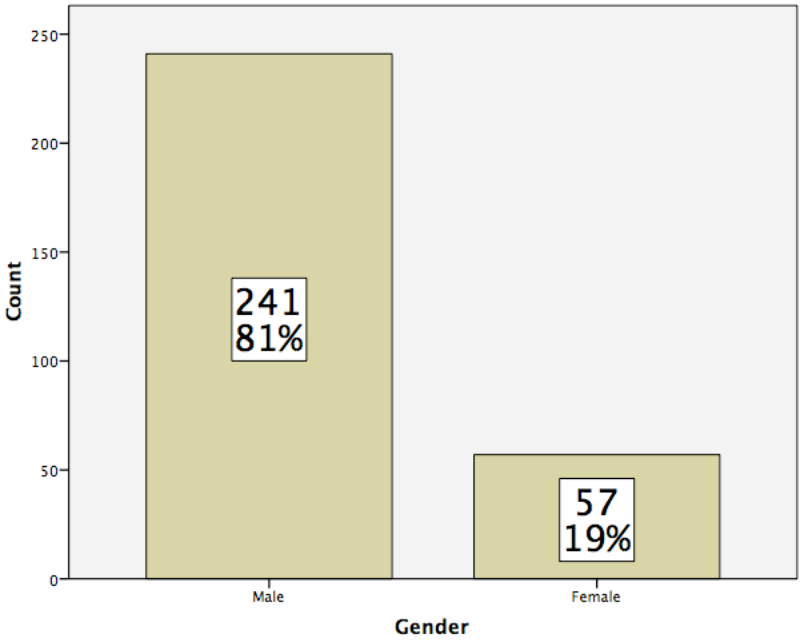
Sent out

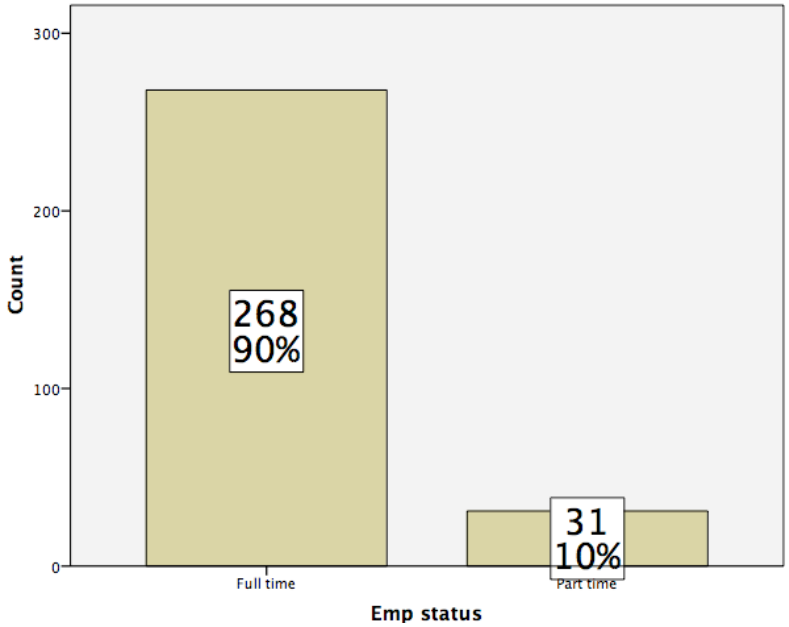
- 4500 questionnaires & one set of reminder – e-mails
- Personalized emails sent to all Canadian University Mathematics Instructors listed in official websites of departments of mathematics (**1913 emails**)
  & one set or reminder emails
- Email sent through a mailing list of CEGEP mathematics instructors in Quebec

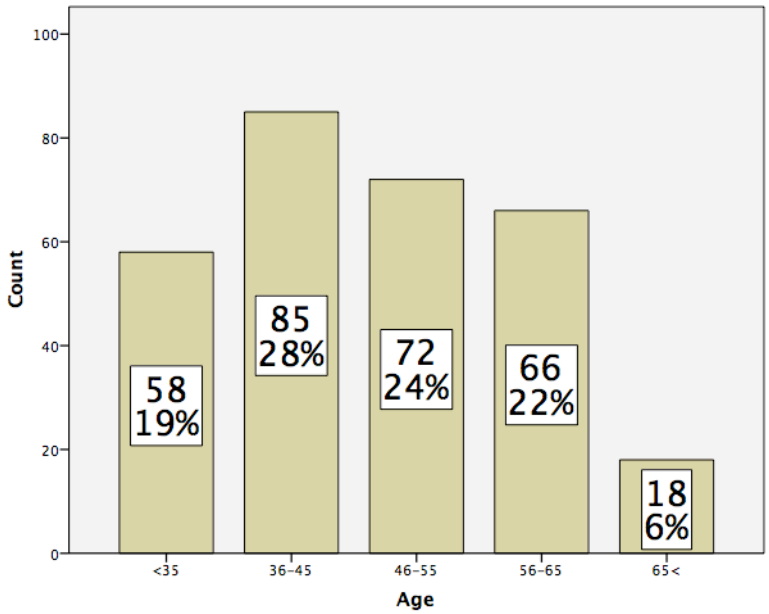
Received

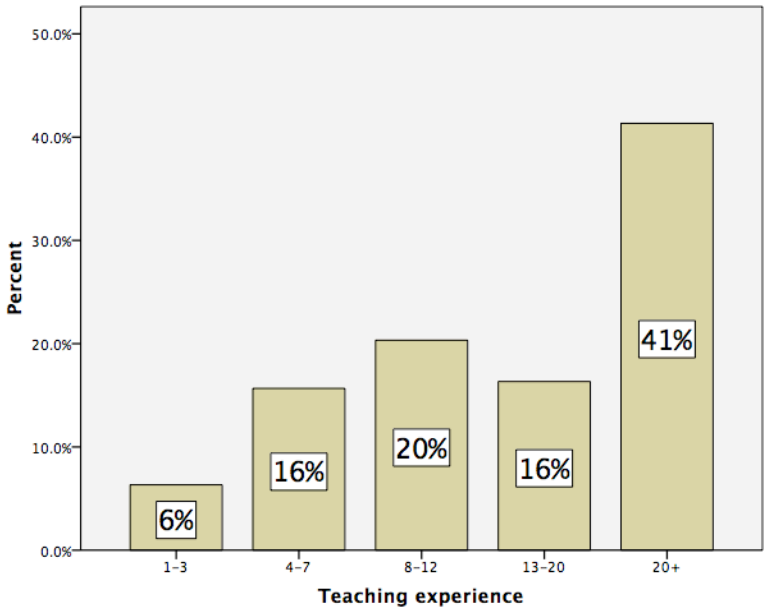
- 521 US (20%), 347 UK (25.2%), and 235 HUN (46.35%); n = 1103
- (Average 25% response rate for all three countries)
- English (223) and French (79): about **16%; n = 302**

Participant Descriptions









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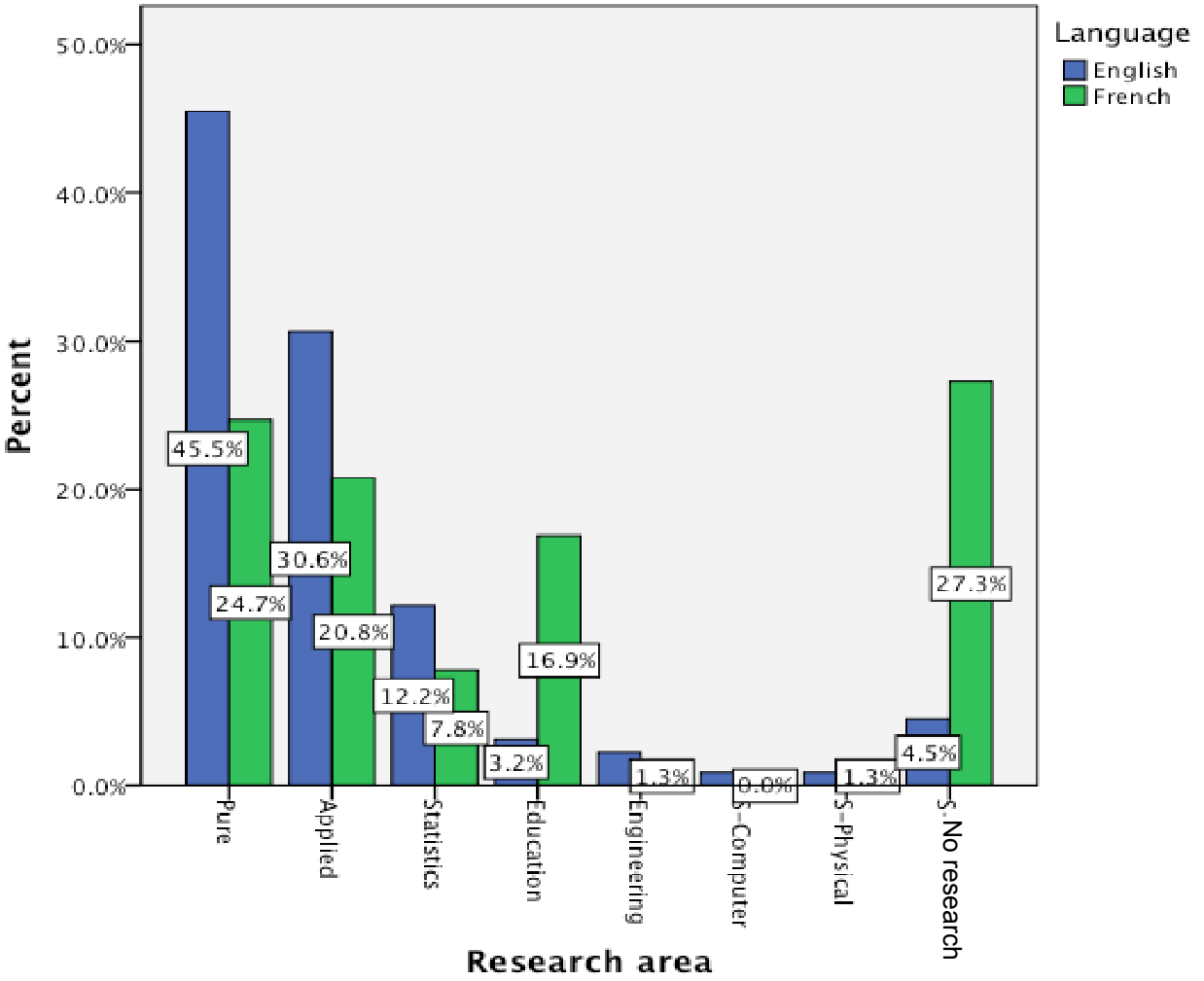


"Which of the following most closely matches your primary research area?"

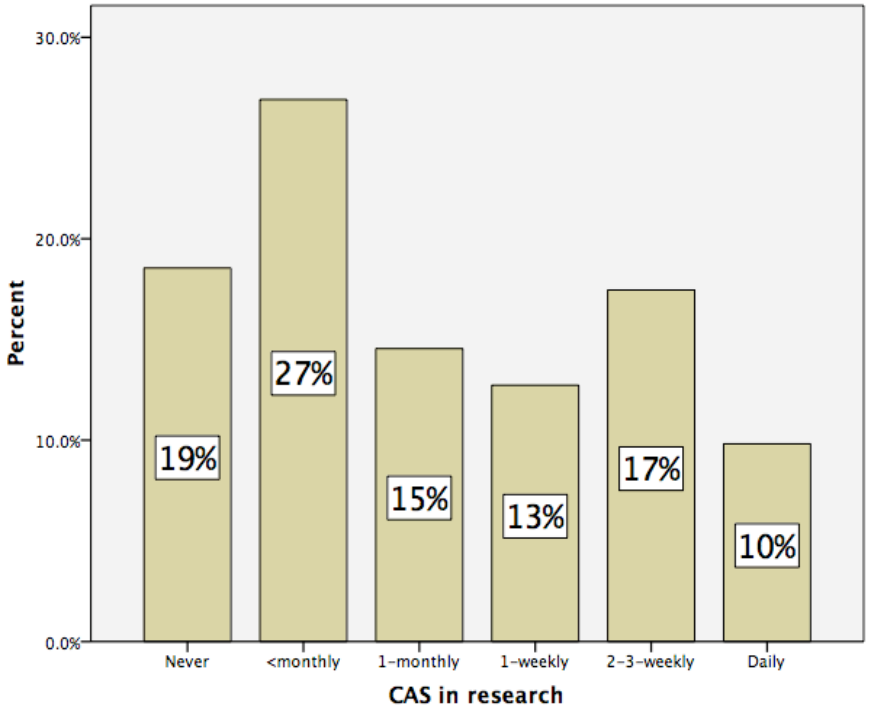
Findings

CAS in Research

81% of all responders use CAS in research

(Lavicza: **67%**)

In an average working month, how frequently do you use CAS in your research?



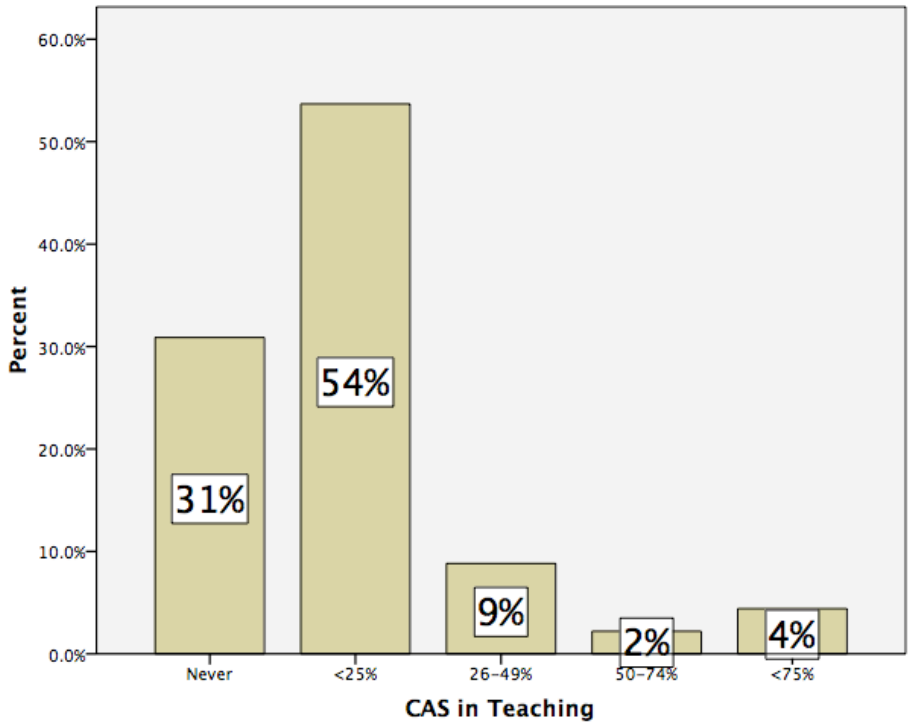
Findings

"In a typical academic term, in approximately what percentage of your lessons do you use CAS?"

CAS in Teaching

69% of all responders use CAS in teaching

(Lavicza: **55%**)

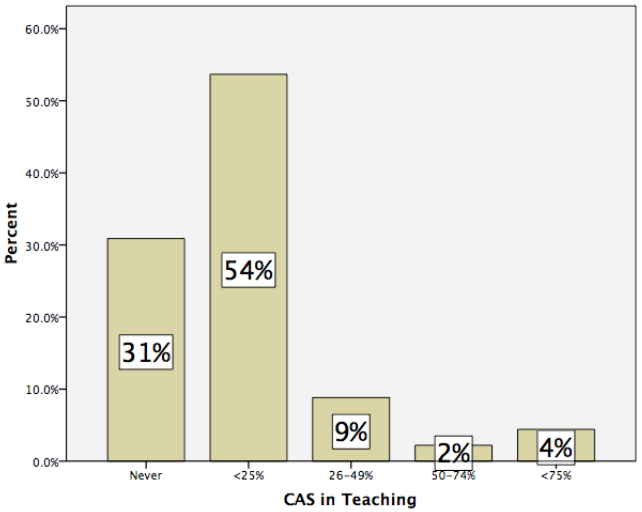


teaching

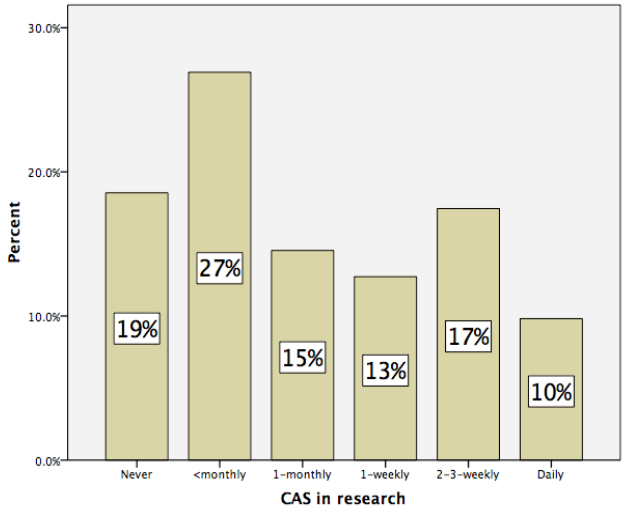
Findings

CAS in Teaching versus in Research

31% of all responders never use CAS in teaching whereas only **19%** never use it in research



teaching

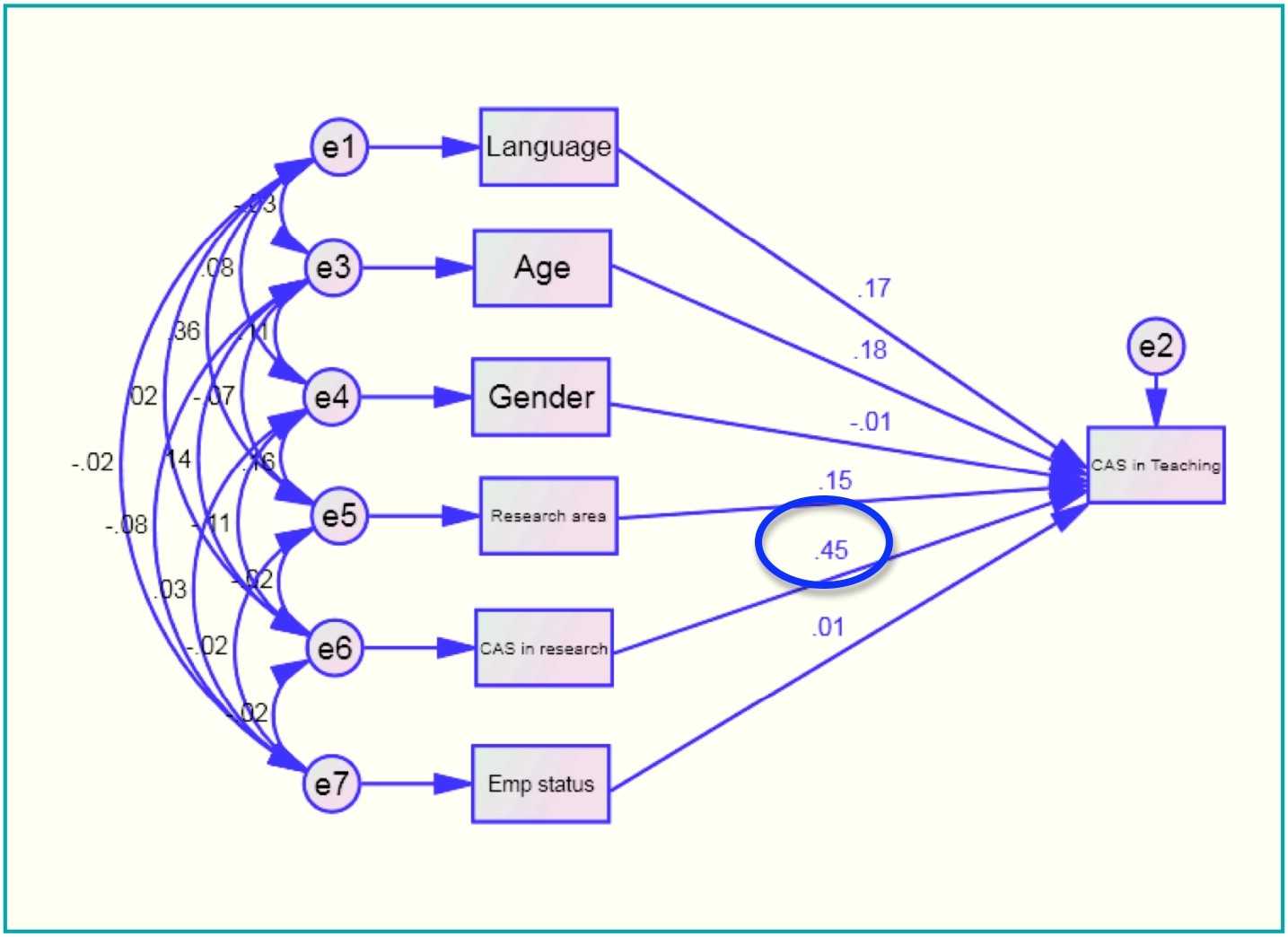


research

Findings

The use of CAS in research is the strongest factor (0.45) affecting CAS integration in teaching by responders.

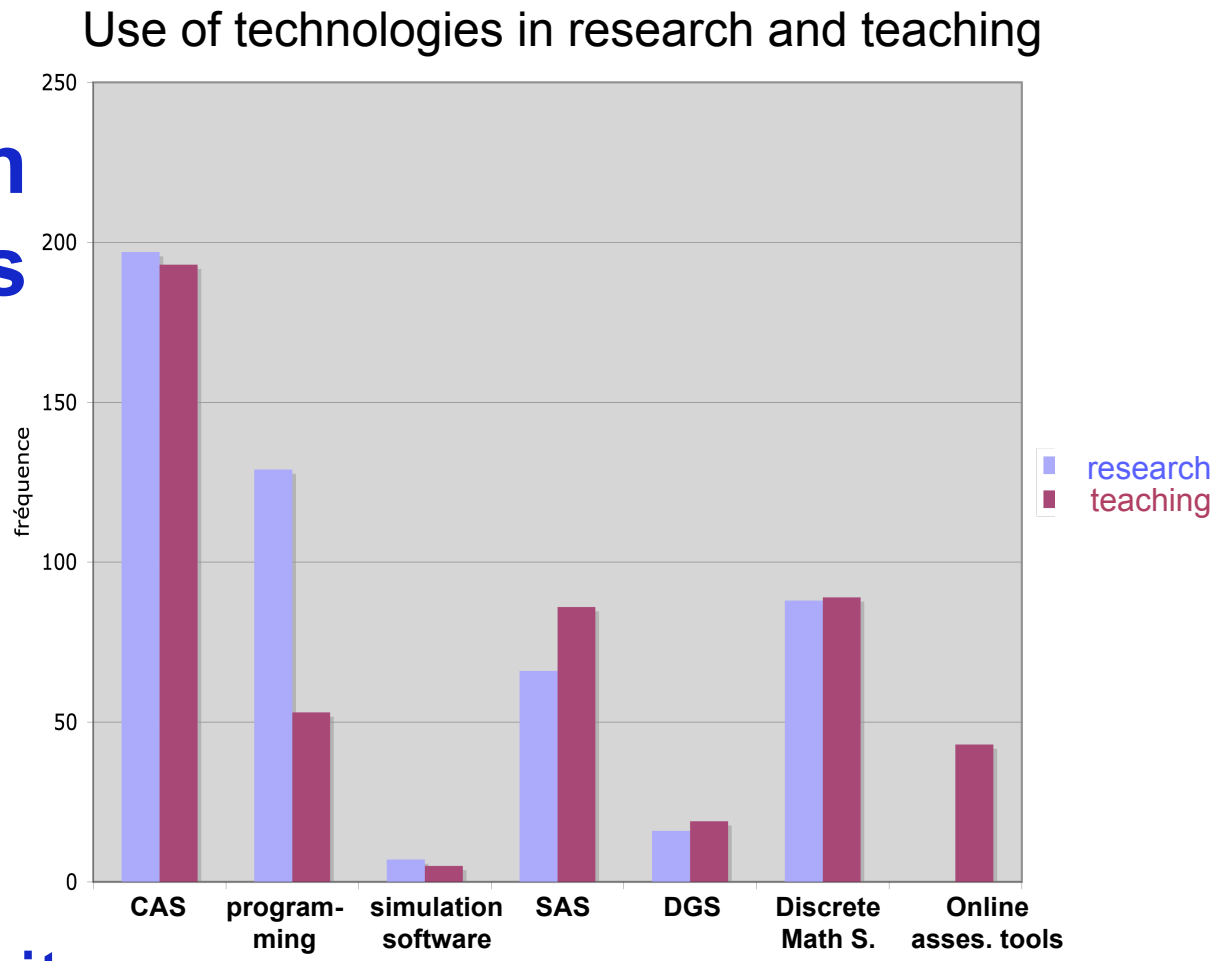
The results are similar to the findings (0.30) of Lavicza (2008) in his study of math instructors in Hungary, UK, and the US.



Findings

Technologies in teaching versus in research

Programming is much more integrated in research by all responders than it is in teaching

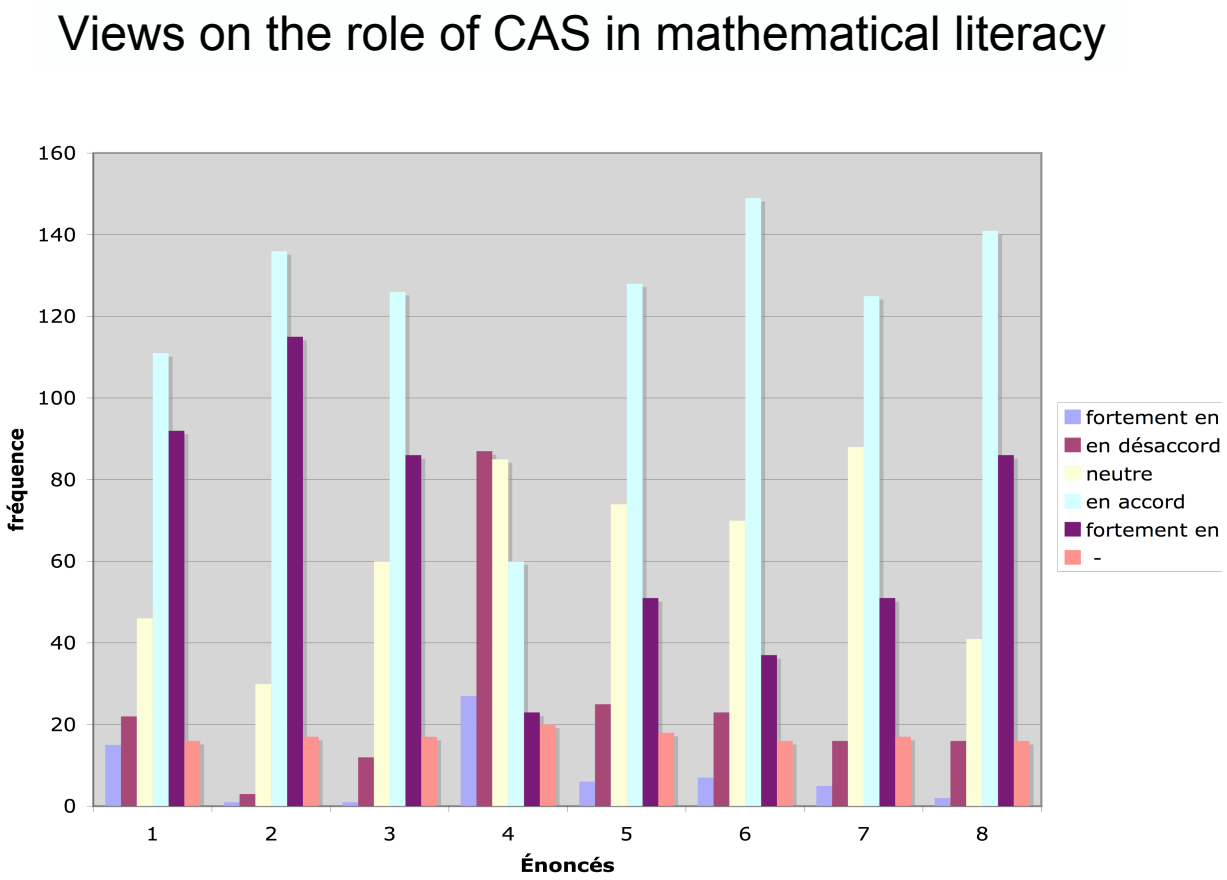


"What kinds of technology have you used in your own research/teaching?"

Findings

Views in the role of CAS in mathematical literacy

Overall responders positively view the role of technology in the mathematics curriculum and mathematics literacy



Views on CAS Use in Teaching

CAS should be used when it helps (and never when it interferes with) focus on the concepts at hand. The question "does this make things clearer?" must always be considered first.

CAS is a tool like a pencil or a hammer. There is an occasion when it will be useful and should be utilized without difficulty when this occurs.

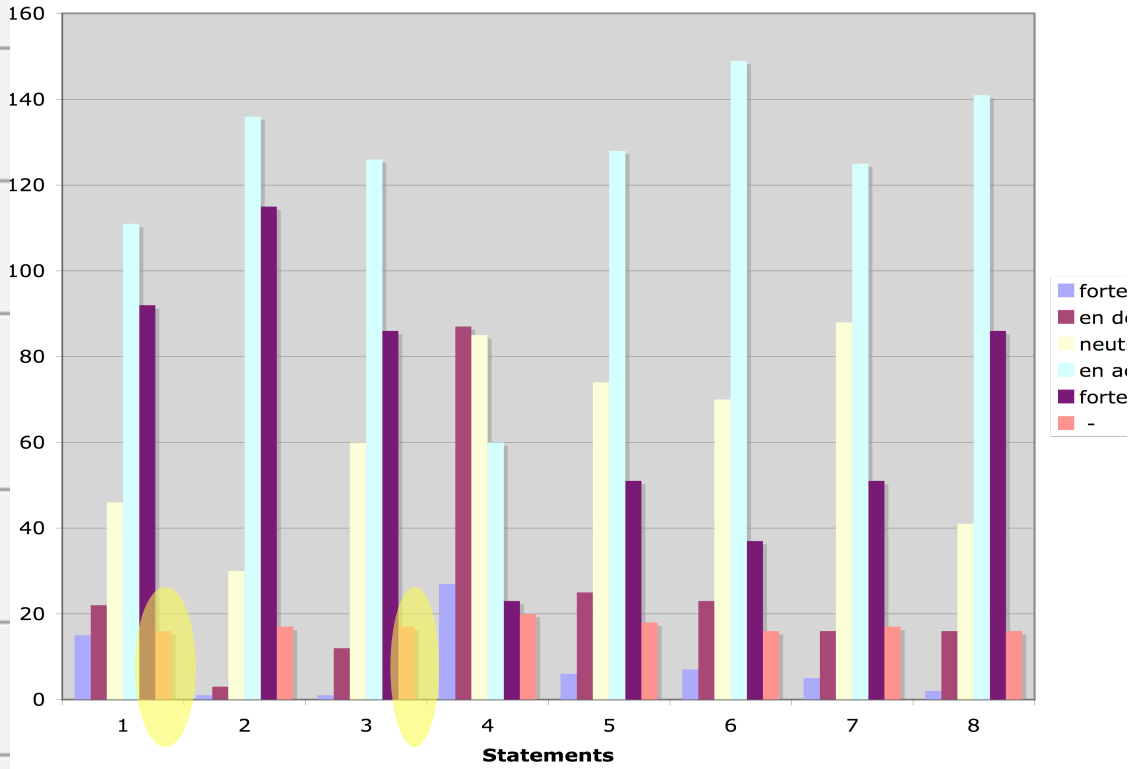
I use CAS only when I believe it will help the students understand better. There is a temptation to use it for entertainment, but I try to resist this.

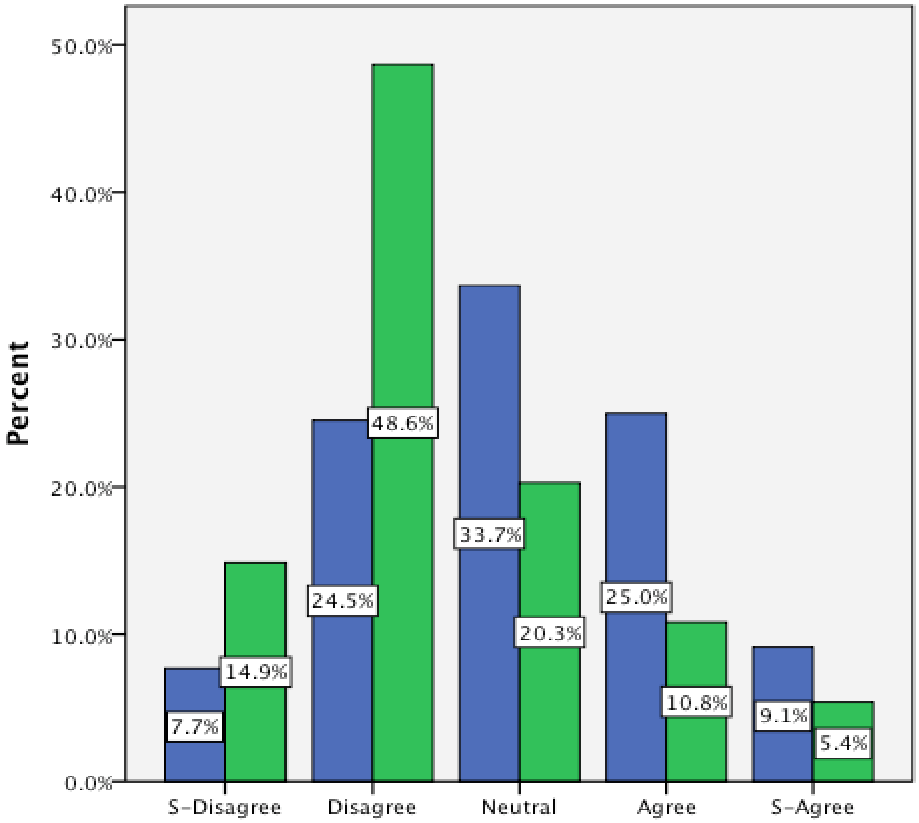
When CAS is used, students tend to think of the course as ONLY CAS. They need to be reminded CAS is a "tool" to assist in understanding what is taught and to bolster it, unless of course CAS is directly related to computational techniques that need to be implemented using a computer language/programme.

Statements

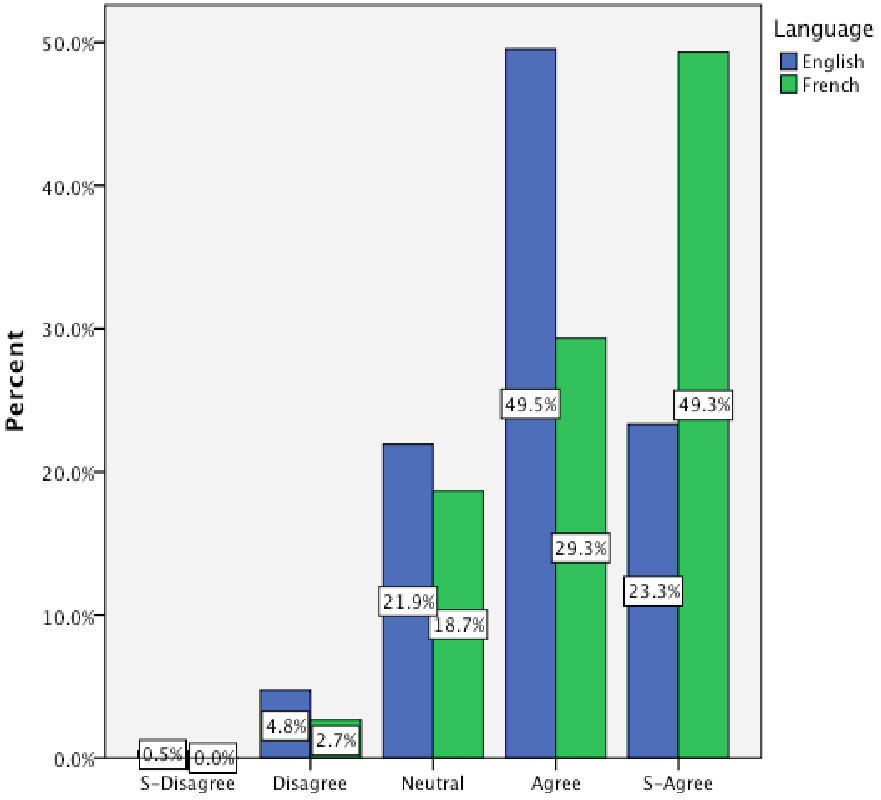
1. Knowing how to use CAS is an essential skill for mathematics graduates
2. Knowing how to use CAS is beneficial for students in science and engineering courses
3. CAS enables mathematicians to work on problems more efficiently
4. CAS use does not affect the mathematics that has to be learned by students in post-secondary institutions
5. CAS is changing the way in which mathematics research is done
6. CAS offers the possibility of introducing new topics into undergraduate mathematics
7. Knowing how to use CAS enhances students' future employment prospects
8. Science and engineering graduates should have a working knowledge of CAS

Views on the role of CAS in mathematical literacy





"CAS use does not affect the mathematics that has to be learned by students in post-secondary institutions."



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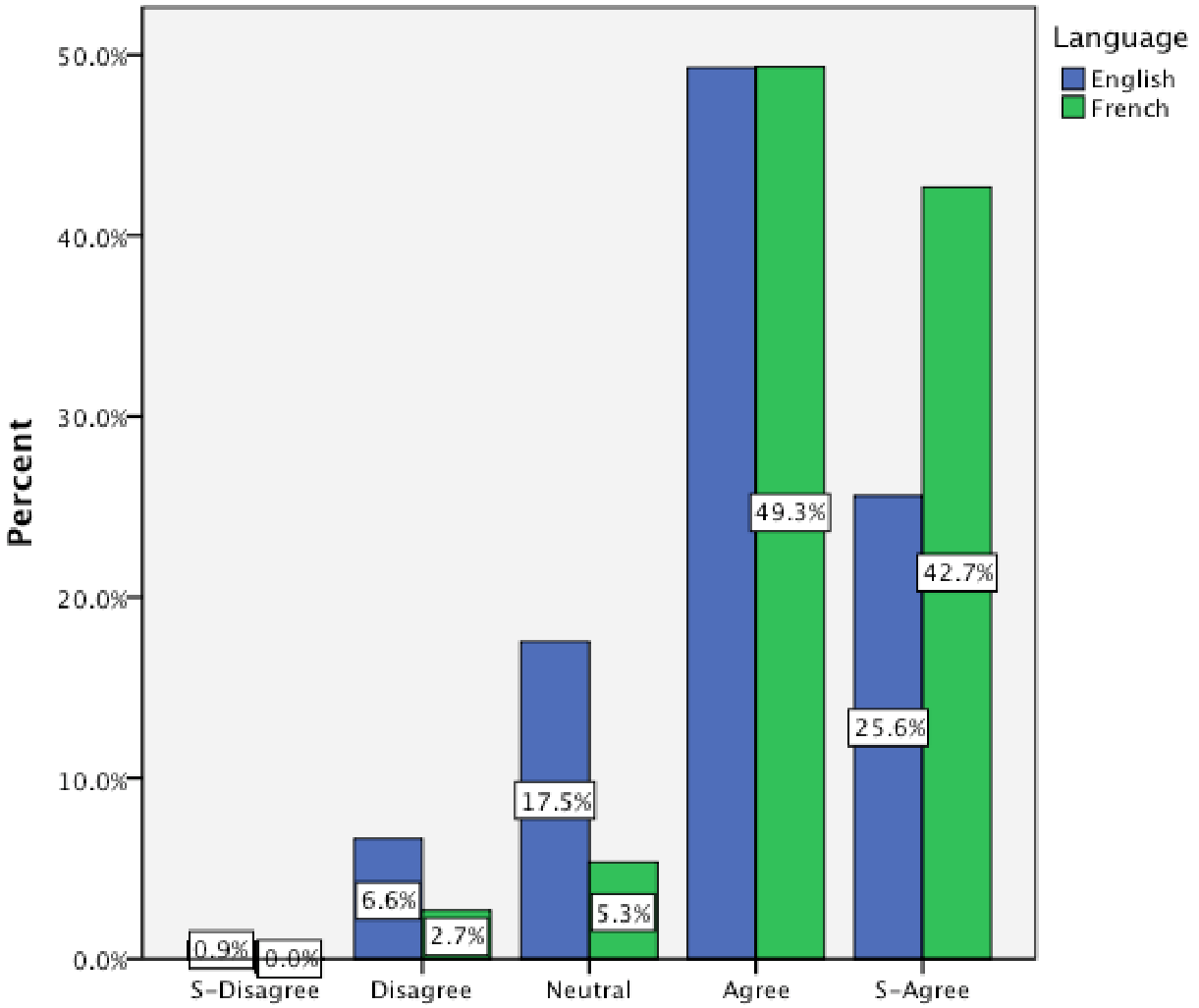
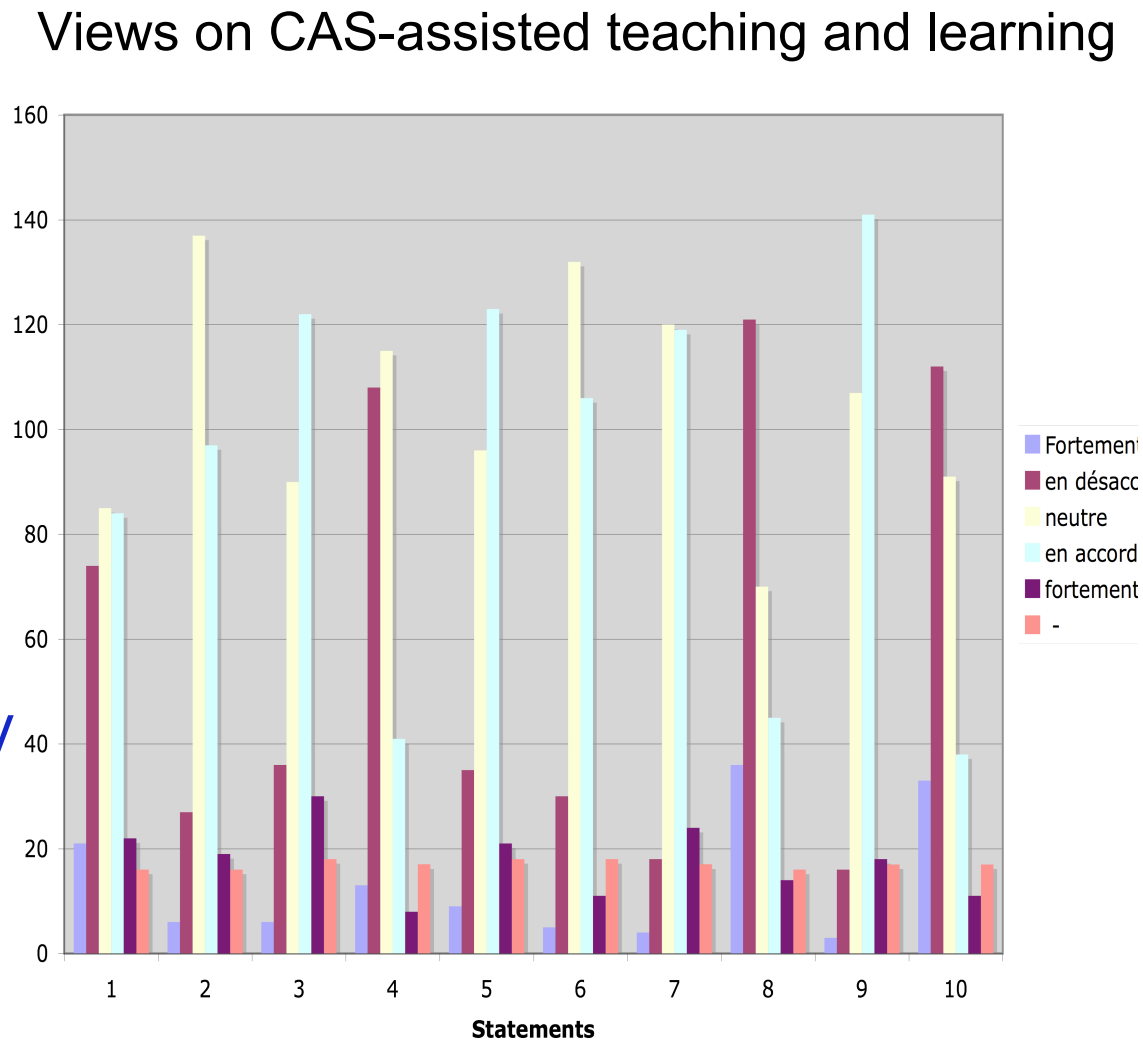


"Science and engineering graduates should have a working knowledge of CAS."

Findings

Views on CAS-assisted teaching and learning

Overall respondent mathematicians positively view CAS-assisted teaching and learning



1. CAS use encourages students to examine carefully the meaning of their solutions

2. CAS use has positive effects on students' enthusiasm for mathematics

3. CAS enables teachers to deliver more engaging lessons

4. CAS use does not make classes more interesting for students

5. CAS use helps students develop better understanding of mathematical concepts

6. CAS use can initiate in-class communication between students

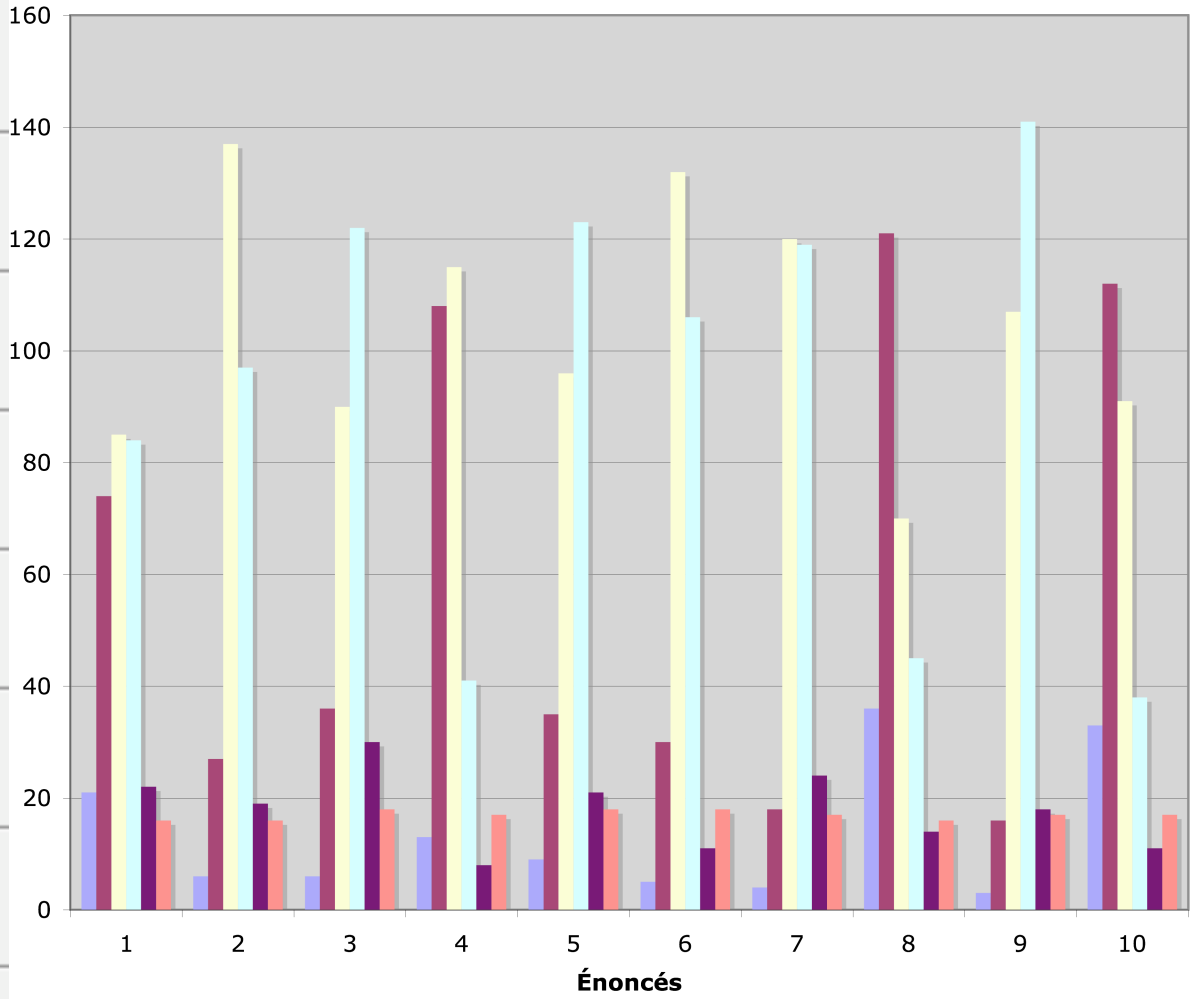
7. CAS-generated images spark valuable discussions in class

8. CAS use does not help students to understand mathematical concepts

9. Images generated by CAS improve students' attention in class

10. CAS use distracts students from understanding mathematical concepts

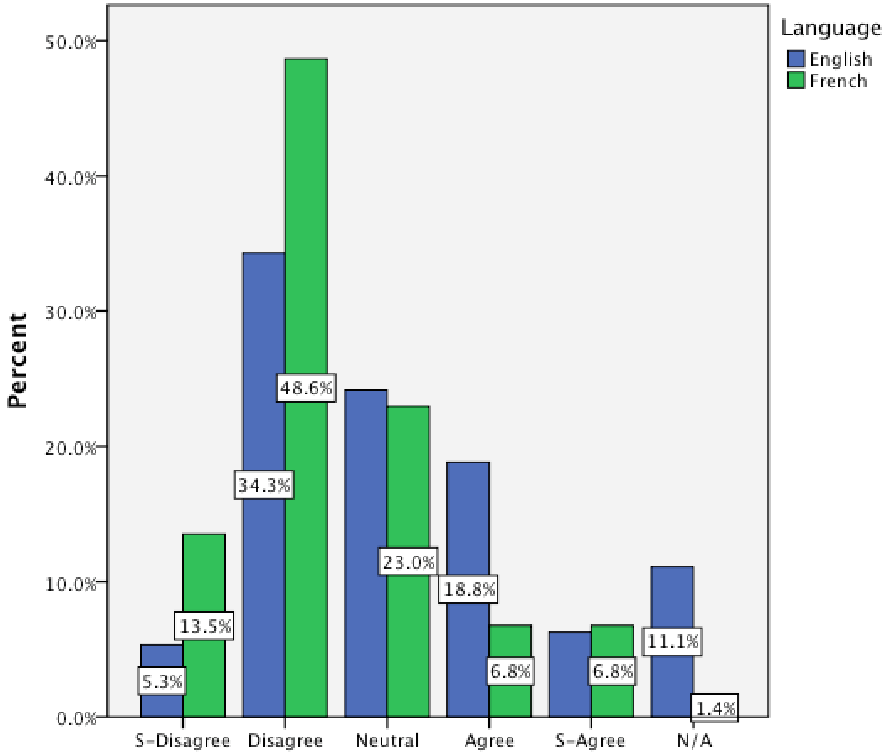
Views on CAS-assisted teaching and learning



Findings

An example of a potential factor that may hinder the integration of CAS into teaching

The cost for CAS doesn't seem to be a factor hindering its integration.



"CAS is too expensive for wide integration in mathematics teaching and learning mathematics."

What non-CAS users say is the biggest reasons to hold back (Question 20)

My impressions of CAS are somewhat negative. My main experience of it is of students in upper level Stats courses using Maple frequently to evaluate integrals which they should be able to evaluate analytically. To that extent it seems to encourage intellectual laziness. I have an open mind on it's proper role however and am prepared to be persuaded that it might be useful in certain limited circumstances.

I prefer to use chalk and blackboard which cannot malfunction and which remains a very effective way to communicate mathematics.

Est-ce que c'est plus rapide et précis d'utiliser les LCF que de faire les calculs à la main. Je n'utilise les LCF que si je crois que les étudiants ont déjà maîtrisé les calculs.

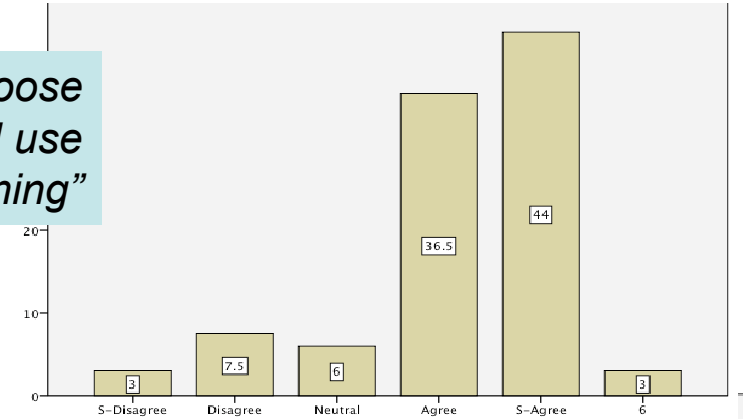
Mauvaises experiences dans le passé.

Findings

CAS and Departmental Culture

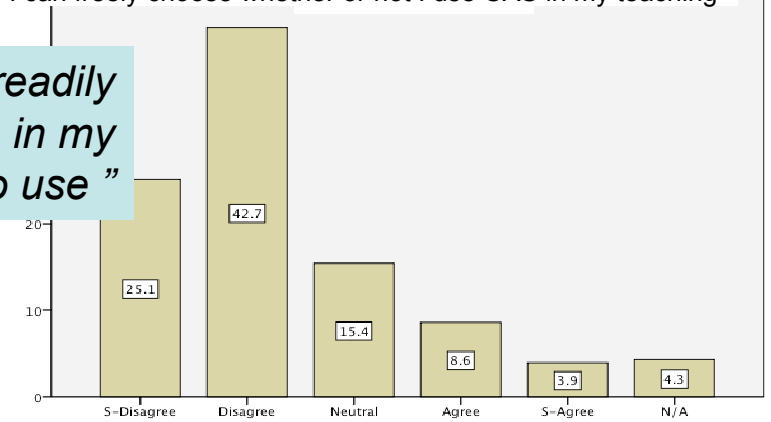
While departments do not appear to discourage CAS use, and while CAS seems readily available to use in many departments, the use of CAS appears to remain at the discretion of individuals (not compulsory)

"I can freely choose whether or not I use CAS in my teaching"



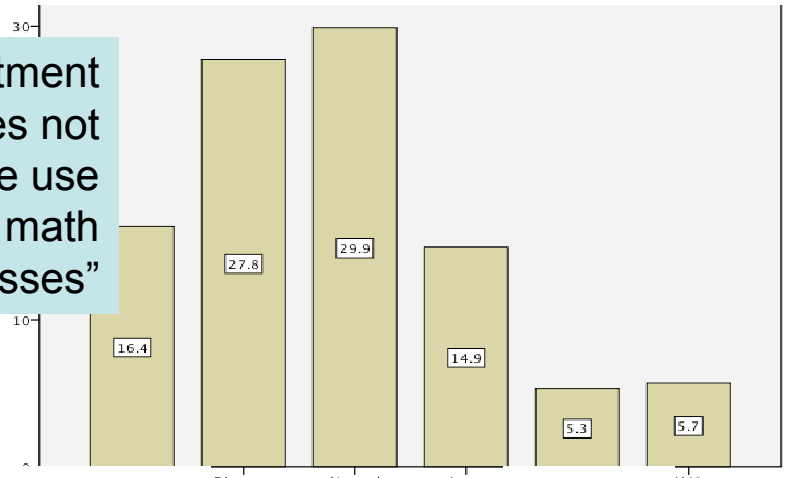
I can freely choose whether or not I use CAS in my teaching

"CAS is not readily available in my department to use "



CAS is not readily available in my department to use

"My department does not encourage the use of CAS in math classes"

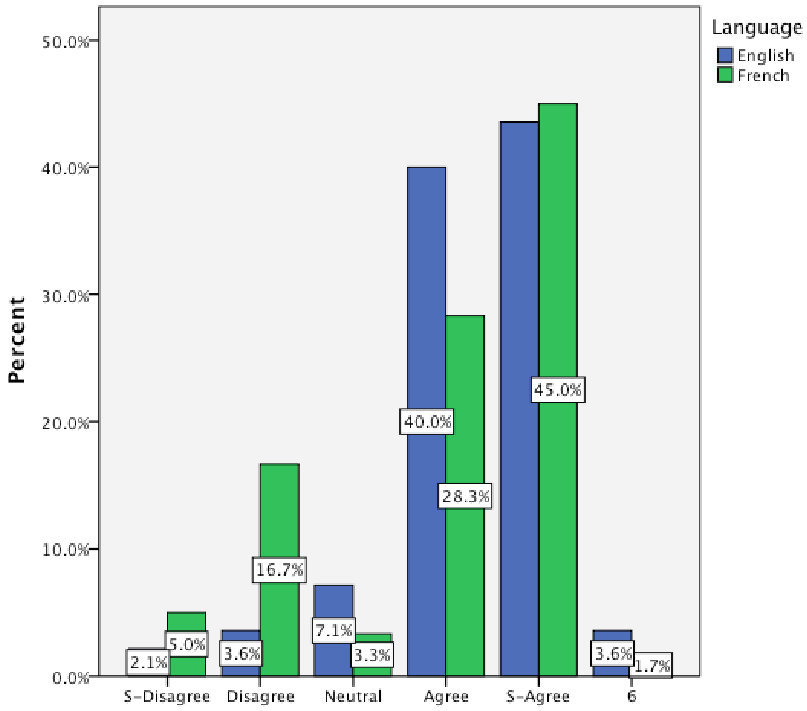


S-disagree

it does not encourage the us

S-agree

classes



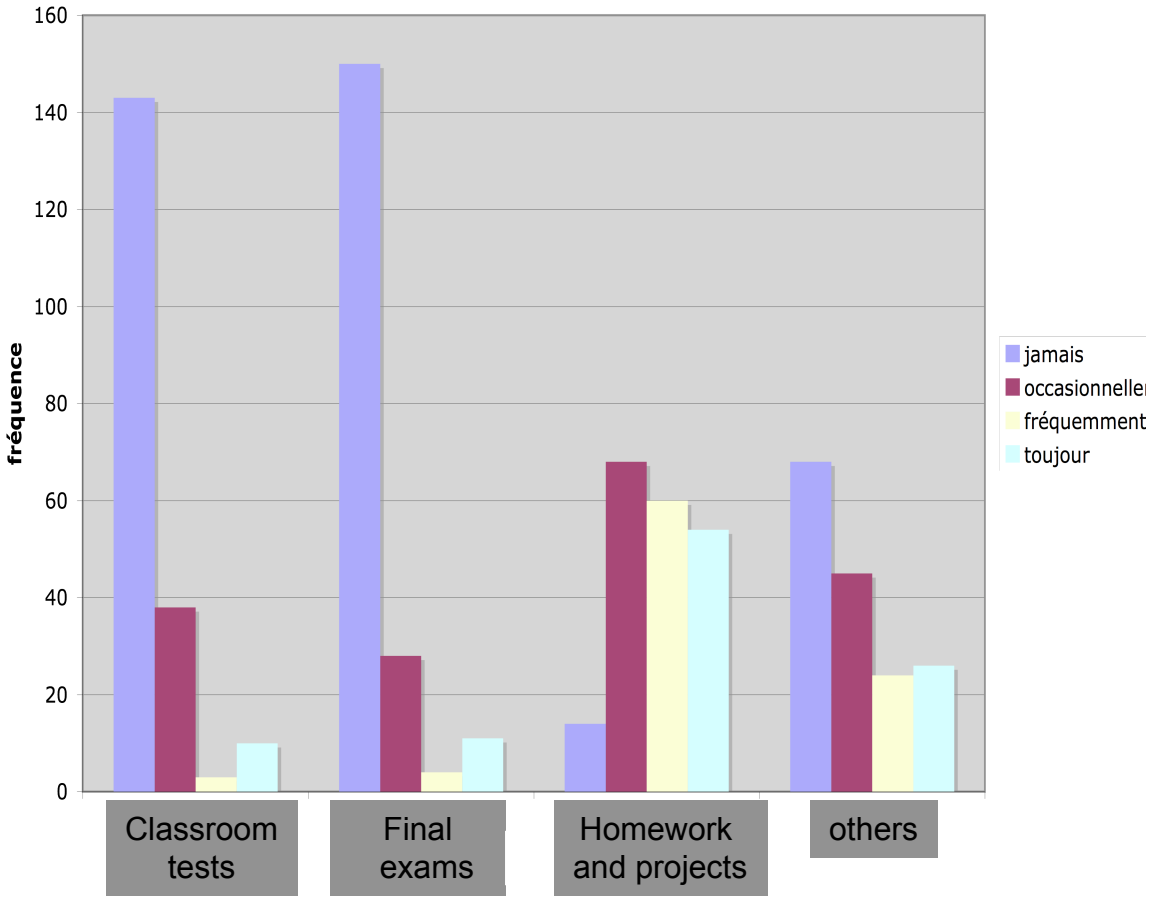
"I can freely choose whether or not I use CAS in my teaching"

Findings

CAS in Assessment

Only **22.3%** of all CAS user responders integrate CAS, at least occasionally, in final exams and **26.3%** in classroom tests

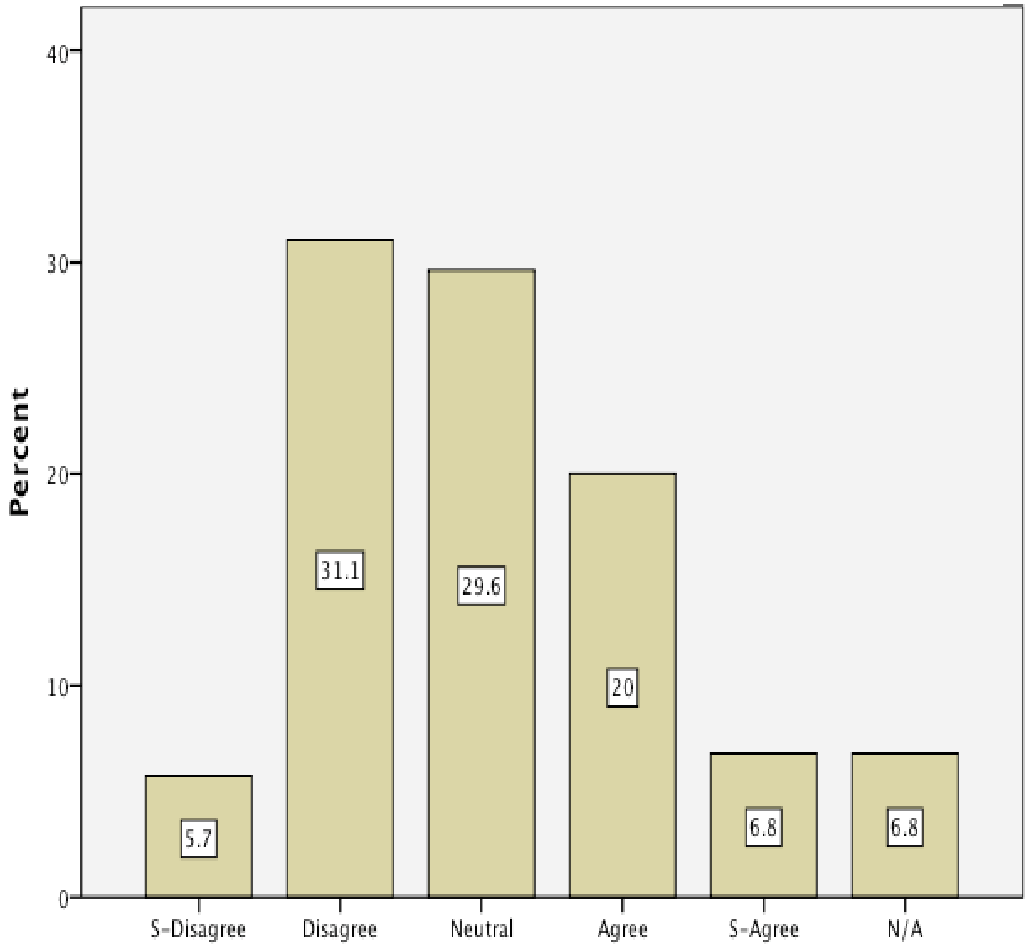
"Do you permit CAS to be used during assessments?"



CAS in assessment

Only **37%** of all respondents don't believe that *it is difficult to assess what students know if they use CAS in tests*, but only about **17%** use it in tests.

"It is difficult to assess what students know if they can use CAS in tests."



Limitations of Research

- Response rate: not precisely known (no master list of mathematicians) and issue with the URL for the survey

  Compléter le sondage (en français):
  http://href.hu/x/8dsw

  Take the CAS Survey (in English):
  http://href.hu/x/8dsv

- Some questions asked about teaching practices without separating courses in the wording of the questions
- Issue of participation rate versus in-depth questionnaire
- Some data had to be ignored due to the missing 'N/A'
- Bound to the international survey

With what level of courses do you usually use CAS?

25) With what level of courses do you usually use CAS?

	Never	Occasionally	Frequently	Always
Cégep - first year (Quebec)				
Cégep - second year (Quebec)				
Entry level undergraduate (1-2 years)				
Higher level undergraduate (3-4 years)				
Masters level				
PhD level				

Preliminary Results*

- Mathematicians use technology for teaching more extensively than (at least as much as) school teachers
  - Mathematicians in Canada use CAS at least as extensively as those in US/UK/Hungary
- Overall mathematicians positively view the role of technology in the mathematics curriculum and literacy
  - Mathematicians in Canada have similar views.
- Mathematicians are open to enhance their teaching practices with technology and to experiment with innovations in mathematics teaching
  - Mathematicians in Canada showed similar interest.

* Lavicza (2008)
Canadian survey

Final Remarks

- Decrease of enrolment in STEM subjects—need to think about technology integration in math programs *(working group at CMESG 2010 meeting)*
- Our research specifically aims at directly reaching mathematicians:
  - Canadian Online Survey of CAS Usage (2009) *(planned article in CMS Notes)*
  - Case Studies of Technology Integration (2008-09) *(recommendations for individuals and departments)*
  - Workshops (Fields & CRM in October 2010)
  - Website with accessible findings/papers/resources for mathematicians/departments interested in instructional/systemic technology integration (2010)

    http://www.nipissingu.ca/casresearch