Comments from participants at the CAME 1999 meeting at the Weizmann Institute

Participants were encouraged to write down points made in the discussion sessions following presentations, reactions and keynote talks. These are recorded below. It is worth noting that these notes are unlikely to make a great deal of sense to people other than participants and those who have read the pre-proceedings closely.

Forum 1: Jean-Baptiste Lagrange & Steve Lerman

3 months on an algebra task — wow!

Lerman's 'student-induction' task: missing the "little joy" by using CAS

On Lagrange on techniques: In these times (technological times) a didactic of techniques should be seen as "expert knowledge". Technology should enable us to make a shift to more conceptual mathematics.

Lagrange's paper is a prelude to an ongoing analysis/discussion of the place of 'techniques' in CAS work. (John Monaghan)

Forum 2: Edith Schneider & Ted Eisenberg

Thoughts to the presentation of Edith & Ted:

- We have to involve CAS in our teaching!

  Because:- When our goal for education in general is to lead the pupils to be self-confident, independent, democratic personalities, it is unfair to hide or forbid modern equipment!
  - Pupils need the knowledge of a successful use of technology for their future professions!

- Answers to the questions where and how we have to use CAS cannot only be given by theoretical, "part research", but as well by observing,
- Supporting engaged teachers! — This support for those teachers can be help from the Government, free time for research, financial support for equipment, ...!

Baerbel

To Ted

Apart from dynamic geometry software, all (?) technological innovations now being used in maths education have been driven by forces outside of education: marker; mathematicians; scientists etc.

We certainly can't afford to ignore them. Research suggests we can use them usefully in education.

Isn't it the case that [young] faculty in mathematics departments use CAS, spreadsheets, statistics packages in the same way that just about all of use use word processors?

Steve

Reactions to Ted Eisenberg

You need to teach people how to use technology or it is just "dead metal"? It does not matter whether this is a place or a calculator. Technology is not a sufficient condition to improve education.

Giora Mann

To Ted

Regarding square roots: This has an analogy with lawnmowers/scythes. You may need to use a scythe if your lawnmower breaks down, but does this need to be prepared for?

Werner Peschek

Forum 3: Paul Drijvers & Kaye Stacey

"Re-inventing the chain rule" is, in my opinion, a wonderful example for structuring mathematical objects. This good task can lead pupils to a deeper look into maths. I would call this an example for a guided re-invention, and I do not think this is top-down! What do you think?

Baerbel

Often the limitations of a technology can be used pedagogically. For example, asking students to find the maximum value of a function when the maximum does not appear in the default window of a function grapher. Some people claim most of the pedagogical power lies on the boundary. Unfortunately, the limitations of technology move further and further away as time goes on.

Does the main pedagogical power of symbolic algebra systems lie in their limitations? Explore!

Kaye Stacey

* Concept learning is a long ongoing process.

* Regarding resequencing, concepts (C) and techniques (T). Is this: C/C? T/T? C/T?

1. What are the possibilities for new sequences?

2. If we "save time" to what do we reallocate it to?

Forum 4: Zehavi/Sierpinska

Many of the uses of CAS are to give 'new life' to old problems. Two reasons why I use CAS:

(i) so that students can have a variety of approaches (to decide upon)

(ii) students can "hold the red line" on the problem.

No technology itself can bring about a change, it can only have an effect by making other changes

What strategies can be used to make “black boxes” appear less black?

Which “black boxes” appear to be the “blackest” and why? Which “black boxes” are “transparent”?

Proposed examples:

“sin”, “cos” buttons do not appear black

“graph-ing” button does not appear black

“differentiate” button appears black

“solve” button?

Kaye Stacey

Keynote: John Berry

John Berry claimed as a general principle that students should learn CAS features at least a year before they use these features in learning new mathematics.

Surely this is not correct in general. Surely some learning to use technology can occur in tandem with learning the associated mathematical ideas (trigonometry provides an existence proof!) Is it not a contradiction to claim that technology should be integrated fully yet learned separately?

What are the principles that might determine when mathematical ideas have to be well established first, when CAS procedures have to be well established first, and when both can occur together?

Kaye Stacey

General comment

A general comment - CAS and Mathematical Education

One thing that gives a bad name to technology is giving it to the user without proper guidance how to use it.

In too many places students are allowed to use calculators without their teachers showing them how they can be used, even to [suggest] their potential. Most of the time because it was not the teacher’s initiative to use calculators in the first place. And, which is more important, the teacher him/herself does not know how to use the technology properly.

For example, most elementary school teachers don’t know that every calculator can be made into a counting machine by asking it to add one (1, +, + k, =, =, =---). On a graphic calculator it’s even more transparent (0, ENTER, +, 1, ENTER, ENTER, ENTER,...)

The concept of the square root is taught in Junior High school. IF calculators are used in establishing the concept then not only the concept will be understood better, but also the student will be less dependent on the technology.

We try to find a number whose square equals 7.

3	9
2	4

2.5	6.25	
2.7	7.29	
2.6	6.76	
2.65	7.0225	
2.63	6.9169	
2.64	6.9696	etc.

Only after doing with the students a few examples like that (which teach the student, by the way, the concepts of successive approximation, programming, etc) do we use the "root" button. For such students this button is a means to perform the algorithm in one step, much the same as the "x" button is a means to perform the algorithm of long addition in one step. (Another black box is not so black anymore).

At the calculus level, one must not teach the concept of derivative the traditional way and then use CAS as a means to compute derivatives. As with the previous examples, the teacher starts by "zooming in" so that a graph becomes "linear". Then, the students are guided to compute the "slope" of this line etc. Only at the end of this process do we show the students that there is a function that gives this slope as the image of the *x*-value of the said point. Thus the students' understanding of the concept is enhanced by the proper use of technology.

Moral: * More emphasis on the development of ways to integrate the technology into the learning process, and spreading the word about those ways in the teaching community.

* We should be more careful when asking students and teachers about their assessment of the use of technology. Too many times the answer is obvious since they were not exposed to the technology at the proper time or in the proper way.

* The first cars (new technology) were not big competition to the horse (old technology) because they were not fast enough or reliable enough. Only when cars proved their superiority over horses did they prevail. The same goes for digital technology vs. pen & pencil.

Only when it is proven that the new technology enables a much better mathematical education will it prevail.

Giora Mann