

Computer algebra system (CAS) and Mathematics education Notes from a discussion meeting

Attending the meeting:

Ian Forbes, University of Edinburgh, Elise Glimsten Högskolan Väst, Thomas Lingefjärd Göteborgs universitet, Mikael Holmquist Göteborgs universitet, Patrik Erixon Vägga gymnasieskola Karlshamn, Tommy Gustafsson Chalmers/GU, Timo Hellström Umeå universitet, Anna Pantzare Umeå universitet, David Sjöstrand Elov Lindälvs gymnasium, Anette Jahnke NCM, Bengt Åhlander Texas Instrument, Per-Eskil Persson Malmö Högskola.

Questions raised in the discussion:

- Why do we still talk about CAS?
- Do pupils lose any skills that are needed using CAS?
- What does it mean to use CAS properly?
- Are there any difference in boys and girls in handling CAS?
- There is problem concerning equality. Can we demand all students to buy calculators?
- What about teacher education?
- Does CAS challenge the teachers in Sweden?
- How should we make the transition from upper secondary to university smoother ?

Ian: I find it interesting that we still talk about CAS after 20 years. This is strange.

In the mathematical education community it seems to be polarized opinions,

In Scotland we are not getting anywhere. CAS is banned. Is difficult to ban some calculators and allowing some. Impossible tell them apart. It is also possible to make a basic graphic calculator into a symbolic calculator by downloading software from Internet.

Basically it is about a fear that algebraic skills will decrease, pupils will lose some skill if they use CAS.

In 2000 we published the ACME report and gave recommendations one of which was to extend the use of advanced calculators to include CAS.

Recently there has been a report, Mathematics: understanding the score, Ofsted, see

<http://www.ofsted.gov.uk/Ofsted-home/Publications-and-research/Browse-all-by/Documents-by-type/Thematic-reports/Mathematics-understanding-the-score>

The conclusions are that more children are passing exams and getting grades but they are not able to think "outside the box". Fazed with unfamiliar problems they fail.

In UK and Scotland the extended assessment system is a problem. It is the tail wagging the dog!

Timo: In Sweden CAS is allowed since fall 2007 at the national tests. Our instructions from the National Agency are that students should not be in favour using CAS during the test. It is very difficult to construct "CAS neutral" problems. It seems like it makes the test more difficult. More problems concerning reasoning and less about calculations. Problems involving finding a general formula to an investigation are moved to the paper-and-pencil-part,

Ian: Many countries have gone through the same problems you have. Bernard Kützler has studied these questions. This is not the way to go. You really need to adopt CAS.

Timo: Maybe we should look more at the work done by CAS CAT, at Melbourne University,

<http://extranet.edfac.unimelb.edu.au/DSME/CAS-CAT/index.shtml>.

Peter Flynn, Lynda Ball etc

David: We are to focus on the national tests. As a teacher you are suppose to regard *everything* when giving a grade. We can, during the course, give pupils tasks concerning CAS.

Thomas: The national tests are very important, a lot of pupils are studying them. It is a problem that the test is not up to date concerning CAS.

Anna: Umeå university recently got an assignment to investigate if it is possible to develop two parallel tests for Mathematics course E, one test there CAS is really needed and one test only with graphic calculator. Then it is up to the teacher to choose which test is the most appropriate for their pupils.

Ian: There is a problem with equality. How to tackle this? Can we demand pupils to buy calculators? Support to some families? In Scotland we cannot require them to buy it but in point of fact if the students are sold the idea and use it all the way through school and in the exam, then the parents buy it. The school can organise the purchase so they get discount and all use the same machine as a result. There are hardship schemes for those who really need support.

Timo: In Sweden almost 100% have graphic calculators but only 3-5 % have CAS calculators. This is in the test situation on the higher lever tests.

Bengt: At the Science and Technical programs all are using GraphicCalculators. TI has about 80-90 % of the market.

Anna: Are there any difference in boys and girls in handling CAS?

Per-Eskil: Not what we know of really. For example, Burrill, G., Allison, J., Breaux, G., Kastberg, S., Leatham, K. & Sanchez, W. (2002). *Handheld graphing technology at the secondary level: Research findings and implications for classroom practice*. Dallas, Texas: Texas Instruments. One of the issues in this meta-analysis is possible gender differences in performance, of which the authors have found none of significance. If any differences are observed, those can mostly be explained by the different ways that boys and girls might approach something new and unknown.

Anna: I do not think there is much research done about this.

Ian: Do they lose any skills that are needed? There is a lot of research supporting the use of CAS if it used properly. See Case of CAS, <http://www.t3ww.org/cas/index.html>

Anette: What does it means to use CAS properly?

Ian: They must be able to have some basic skills with pen-and-paper. And using CAS they must be able to justify their answers, they should be made responsible for the answers.

How far do they need to go with paper and pen? What is the purpose? Not that far.

We need to look at the bigger picture, what is that we want our students be able to do? CAS challenges the teachers and scares some of them. Pupil's starts asking questions using the calculator - they always come up with something you as a teacher not seen.

Anette: Do you agree that CAS challenges the teachers in Sweden?

Per-Eskil: As a teacher you have very little time to develop your teaching. We have very little help. I have learned on my own. CAS demands a lot from teachers. Kathleen Heid said that CAS either amplify that you already do as a teacher or make you reorganise all you used to do, <http://www.ed.psu.edu/educ/c-and-i/faculty-and-staff-gallery/m-kathy-heid>

Bengt: As a teacher I find when using CAS that you spend more time exploring and investigating, more time to discuss, talk and reason. What about the new teacher?

Ian: If you want to change: First of all support for teachers - how can CAS be used?
Second, train the new teachers with the technology
Third, CAS must be a natural part of the assessments.

Anette: How should we make the transition from upper secondary to university smoother concerning using for example CAS?

Tommy: We do not allow any aids during the exams at Chalmers/Göteborg University. We need to check if they grasped the concepts. Basically, the conceptual understanding is too low.

Ian: This seems to be problem in all of Europe. I prefer open-book test, it is more close to how you work outside school.

Per-Eskil: My son is soon graduating from university and during all years all exams were open-book except the two maths courses in the program. Why he asked?

Tommy: If we should allow CAS, we need to give completely different exams. We need to see if they grasp the concepts, they must know how to multiply matrices for example.

Ian: Do they know why they do that?

Tommy: That is another kind of question.

Ian: Yes, they need to be able to multiply 2×2 matrices - but 3×3 ? In real life - what we do when we need to solve a problem. We use all the help we can get. We need to teach kids to use all information. My experience is that older universities do not have to change, they get students anyway.

Tommy: We do have test in Matlab - the courses are in two parts.

Bengt: Not all teachers get to learn how to use CAS in teacher training.

Ian: In Scotland we do have a very good teacher education. And a committee even visited Scotland, see
http://www.gtcs.org.uk/Publications/MagazinesandBulletins/TeachingScotlandMagazine/Teaching_Scotland_Authorising_Sweden.aspx

Bengt: Teachers used CAS - what are the positive findings?
What are the problems? I am curious.

Ian: We needed homeground knowledge. If we give them CAS, do they forget all algebra? No, not in projects we did concerning six schools. See article,
http://www.tech.plym.ac.uk/research/mathematics_education/field%20of%20work/IJTME/volume%209/number_one.htm#two
The negative effect we saw was that after 18 months they used TI92 less and less, kids did not like the TI92. We were able to switch to TI89, that made a big difference.

Thomas: But CAS is just one “program”. There are more trends involving using technology such as mobile phones, geo caching and free programs to download.

The Horizon report claims that mobile technology and GeoCaching will grow even more, see <http://wp.nmc.org/horizon2009/>

There are Swedish version & instructions for

Maxima <http://www.moglestu.vgs.no/maxima/>

Graphmatica <http://www.graphmatica.com/> and instructions in Swedish

<http://www.graphmatica.com/user/>

GeoGebra – free <http://www.geogebra.org/en/wiki/index.php/Publications>

Articles in Nämnaren, 2008 and 2009.

Bengt: All this programs above is collected in one program TI Nspire where it is the same syntax in the handheld as in the software.

http://education.ti.com/educationportal/sites/SVERIGE/productDetail/se_nspire.html

Anette: What do you want to happen in Sweden?

Summary:

- National test to be more progressive. Maybe more oral test?
- Money to develop classroom activities.
- Get teacher education more involved.
- Website where you can easily find some tutorials, self-education parts, teachers should be able to send in contributions, discuss. Website should be neutral, non-commercial.
- Working condition for teachers must improve so you have some time for development.
- Corporation between mathematicians and upper secondary school teachers.
- Give in-service training all over the country.

Anette: Do you want to meet again?

All: Yes!

Comments by Anette while typing these notes:

Is CAS forcing us to deeply reconsider which math, which competences and why? Is it changing so much that it has to develop *together* with mathematicians? Users?

How much are we driven by our fascination and interests? Does it come down to, what kind of mathematical activities we as teachers, researchers, students find *interesting*? Maybe some do not find it interesting to do mathematics with for example CAS. Maybe the “handicraft”, the slow manipulations appeal to some. Are both ways possible?