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Using CAS in the classroom: personal thoughts (Part I)

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My first contact with computer algebra goes back to ***Derive*** in 1991. I will never forget what was written in the user manual introduction ([1]): «Making mathematics more exciting and enjoyable is the driving force behind the development of the ***Derive*** program. The system is designed to eliminate the drudgery of performing long tedious mathematical calculations. This gives you the freedom to explore different approaches to problems – approaches that you probably would not even consider if you had to do the calculations by hand ». And this also applies, at different levels, to many other computer programs (CAS but also DGS for instance).

Some textbooks contain many interesting exercises where use of CAS is recommanded but not mandatory. In [2], I don't often feel the "freedom to explore different approaches to problems" despite the fact that the book contains many exercises where the use of a computer is required. But in other cases (namely in [3]), heavy use of computer algebra makes a new way of teaching mathematics possible. Since many years, I have decided to add in my teaching some aspects not covered or not enough exploited by textbooks (this decision would have been difficult to take without the adoption of CAS technology all over the campus). But I have also decided to skip some "classical stuff": teachers should not forget the length of a semester is still the same! The talk will be about how CAS technology can be easily used to teach subjects where only pencil and paper techniques would discourage the user. Texas Instruments CAS software will be used for the computations. The first item in the following list will be used this year for the presentation. Future ACA conferences should be an occasion to select among the others.

- Computer algebra systems solving facilities can produce huge expressions users must be dealing with. Sometimes, the simplification of a formula can require a high level of manipulations. And this is where the teacher could act as a guide for the student. Here is an example: use a third degree polynomial equation where your students are asked to solve it using Newton's method. Then, take a look at the exact solution returned by a CAS and get the opportunity to use calculus, talk about Cardano's formula and trigonometric substitutions.

- Integral tables in calculus textbooks should be updated in order to benefit from more thant 30 years of computer algebra! Why not try to use a table where symetry among formulas becomes a goal whenever it is possible as the Rubi system does ([4])? A better choice of antiderivatives, the search for continuus antiderivatives and more explanations on the constant of integration should become new subjects instead of spending (too much) time on integration techniques.
- Real analysis and complex analysis don't seem to fit with computer algebra. But many concepts in (real and complex) analysis can be introduced and/or illustrated by CAS. Pointwise convergence of a series of functions, the Gibbs'phenomenom are examples. A built-in Laurent series function could be used to check the computation for a residue at a pole; the unwinding number could be used to verify some equalities involving logs and general powers as chapter of [5] ; 2D and 3D plotting facilities can be used for different transformations or to solve equations.

Some among us thought computer algebra systems were going to change the way we teach mathematics. It did but not as much as we would have expected. Blame for this whatever you want: the textbooks, the teachers, the students, the curriculum, the system. But things are not so bad: using CAS, many mathematics teachers have given themselves additional years of making "teaching more exciting and enjoyable". And the latter makes learning mathematics also exciting and enjoyable for many students.

Keywords
Computer algebra systems, textbooks.

References

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[4] `https://rulebasedintegration.org/about.html`.

[5] ASLAKSEN, HELMER, *Can Your Computer Do Complex Analysis?*, in *Computer Algebra Systems: A Practical Guide*, 1st Edition, Edited by Michael J. Wester, 1999.

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