Irreplacable contributions of math assistants to learning

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This talk relates recent data from an EU-wide enquiry to general design principles for mechanical mathematics assistants (MMAs), suggesting respective features, which are considered irreplacable contributions to learning.

The data have been extracted from an enquiry with 200 questionnaires filled by students at universities of technology in 7 countries. The data show a significant result: STUDENTS KNOW THEOREMS, BUT THEY CANNOT USE THEM. The majority of the probands not even can use the law of distributivity, a*(b+c)=a*b + a*c, for justifying the expansion of (x-1)*(x+1).

This well-grounded observation raises lots of questions about didactics and psychology: Is it a waste of time to teach students theorems, if finally they cannot use them? What says developmental psychology about justifying formulae by formulae? Is the lacking competence a reason for the uneasiness so many people, even engineering students, feel with maths? Etc.

This talk leaves answers to the above questions to future research; rather, firstly an assumption is stated: the questionnaire has identified a foundamental reason for problems with mathematics, and probably a reason for decreasing interest in related studies in engineering and in science: foundamental difficulties of humans with mechanical operations in mathematics.

And secondly, this talk makes the point: MMAs necessarily encounter students with just these mechanical aspects of math --- thus turn this potential obstacle to a learning opportunity by an appropriate design: make MMAs COMPUTATIONALLY AND LOGICALLY COMPLETE, INTERACTIVE MODELS OF MATH, such that they can perform all kinds of computations, such that all steps of computation are justified by logics, and such that learning might happen by interactively exploring the model.

And if designed accordingly, such MMAs provide joyful, even game-based experiences of formal mathematics --- irreplacable, since much more patient and persistent than a human teacher, who on the other side is irreplacable in careful embedment of learning into enriched, meaningful, social scenarios. This is an educational motivation for technical aspects of "convergence on math assistants".