

MOVING OUR FOCUS FROM TEACHERS TO STUDENTS

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Over the last decade, mathematicians have begun to pay more and more attention to how they teach and how their students do (or do not) come to understand mathematical concepts, develop the ability to make calculations, and become good problem solvers. MAA's Project NeXT provides a forum for young mathematicians to ask questions and share ideas about teaching and learning. MAA's Project CLUME runs workshops and minicourses and produces written material all designed to help faculty use cooperative learning as a pedagogical strategy. Activities devoted to mathematics education are now a major part of the annual winter mathematics meetings and the summer MathFest. Finally, our professional publications are devoting increasing space to articles about teaching and learning.

With all of this progress, I think we are ready to take a further step forward and begin to sharpen our critiques of teaching methodologies so as to move from anecdotal analysis to a more solid foundation. We should also try to refocus our attention from what we as teachers do to outcomes in terms of student learning.

The article, "What is so good about them anyway..." by Nora Franzova in the A Different Pencil department of the January 2000 issue of Focus is a good example that illustrates both our progress in becoming more aware of teaching issues, and some of the steps we still need to take.

We can be very grateful to Franzova for the first six paragraphs of this article where she points out that her objections to using technology in her classes were largely based on the unjustified assumption that what worked for her, a future mathematician, was also the right thing for her students who will largely go in different directions. But then in the main paragraph describing the effects of her current use of CAS, she demonstrates how difficult it is to get away from this largely teacher-centered point of view in making decisions about what to do in the classroom.

In the paragraph in question, there are 7 sentences and the word I (i.e., Franzova) appears 6 times as the subject of a sentence or phrase. We are told that the teacher becomes excited, can show, can work out, can stimulate, and can solve. All we read about the students as active participants is that they "like the idea of seeing the final answer and comparing it to the one in the back of their textbook", which is hardly a notion newly brought out by technology. The remaining three paragraphs do not tell us any more about what the author's students are doing or feeling, or, what is most important of all, learning.

As a proponent of and participant in education reform in general and the use of technology in general, I cannot reiterate often enough what I first said many years ago: In the mathematics classroom, in the last analysis, what the teacher says or does is of little or no importance; what really matters is what goes on with the students. (*A Learning Theory Approach to Calculus*, in (Z. Karian, ed.) *Symbolic Computation in Undergraduate Mathematics Education*, MAA Notes, 24, pp. 48-55, 1992.)

Education reform and the use of technology are highly controversial and there is major opposition. Those of use who are convinced of the value of these

innovations will not succeed in bringing our colleagues along by pointing out how wonderful we think the new methodologies are. We simply must start biting the bullet and ask the hard questions about what effects these pedagogical approaches have on students' understanding of mathematical concepts and their applications, on students' ability to perform mathematical calculations, on their attitudes towards mathematics and on the role in which mathematics plays in our students' future professional and personal lives.

One way of doing this is for college mathematics faculty in general to refocus our thinking from the teacher to the student. An excellent and highly readable article by Donald L. Finkel and G. Stephen Monk (*Teachers and Learning Groups: Dissolution of the Atlas Complex*, in C. Bouton and R.Y. Garth (Eds.), *Learning in Groups*, pp. 83-97, reprinted in MAA Notes 44) makes a strong case for such a transformation and gives some first suggestions on how to carry it out.

Another way of increasing the attention we pay to what is going on with our students has to do with a development in our profession over the past decade that is parallel to the development of our interest in pedagogy. I am referring to the rapid growth of the field of Research in Undergraduate Mathematics Education (RUME). New groups more or less connected with the MAA such as the new special interest group of the MAA (SIGMAA) called the Association for Research in Undergraduate Mathematics Education (ARUME), and a Research in Undergraduate Mathematics Education Community (RUMEC) have come into Being; there is a joint AMS/MAA Committee concerned with RUME and which publishes an occasional volume of research papers; reports of research are an integral part of the programs of the annual mathematics meetings; and MAA publications are beginning to include research reports as well as summaries of published research.

So I think that although there is much work to be done and a lot of progress yet to come, we can be optimistic about the future of undergraduate mathematics education. By heightening our awareness of pedagogical issues and incorporating the results of research in our thinking about what might be going on in the minds of our students, we can vastly improve the quality of our teaching. The beneficiaries of this will be our students who will come to understand more mathematics at higher levels of profundity and society as a whole which will benefit from a stronger mathematical research community and a more mathematically literate general population.