CAN WE "BOOT-UP" MATHEMATICS AND REMAIN PROFESSIONALLY HONEST?

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Computer technology has worked its way into the calculus. Well, at least the majority of calculus texts have sections dealing with computer applications. Certainly, those sections can be skipped as we do many other sections we don't have time for or the inclination to include. However, it is no longer justifiable to skip Newton's Method, the Trapezoidal Rule or other numerical methods. One need not read journals or reports, nor try to stay abreast of the thinkers and doers to witness this intrusion into the traditional curriculum; it's staring us in the face. Therefore, the "new technology" will find its way into the curriculum in a kind of natural way and we can hope it evolves into a meaningful influence. So, relax!

Relax, only if you don't read the literature, review the software and distinguish the learning process from the extensions and applications of what is learned. Even the most casual reading of the literature can confuse. When is the computer an aid to instruction and/or its management and when is it an aid in problem solving? This confusion can be very legitimate. For example, iterative processes, tabulation, etc. can serve both purposes quite well. Assuming this confusion has substance beyond confession, can we incorporate the computer into the traditional mathematics curriculum without delineating these roles?

Even if I am the only one confused, don't reject what follows as a description of just a first step towards integration of this technology, for there may be something of value I am not aware of. The attempt to determine what my first step should be forced the realities of teaching at a community college to raise its challenging head. These realities are not as important as the awareness that I must make my bibliography clear: namely, (1) the general literature, (2) the extremes of the subject matter I teach - Basic Arithmetic through Differential Equations - in the same day, (3) the varied backgrounds, learning styles, expectations and epistemologies of my students at each curricular level and in each class, (4) myself - as a primary resource that I must contend with and satisfy in terms of my traditions and perceptions of mathematics education, and most importantly (5) my students! It was the latter which directed me to the first step in answering how I can incorporate computers into the traditional curriculum - other than applying for a grant and duplicating someone else's ideas, research and efforts.

I designed a course whose objective is to interact with the computer as it applies to the traditional calculus. The purpose was to be free from the presentation of reflexive and manipulative skills; discuss and solve the problems therein and see how the computer can facilitate, enhance, direct and redirect one's thought. Most important was my interest in the response of the student to this type of encounter. I embedded myself in this objective and this purpose, not by design, but necessity. I knew I could deal with the mathematics, but had less than minimal computer expertise. Guts or stupidity? I solicited and found seven calculus students - the best we had. The initial course offering had two Calc I students and five Calc II students. Three of the five Calc II students enrolled for the second half of the course concurrent to their enrollment in Calc III. The two Calc I students had a variety of reasons for not continuing. One reason was they felt unable to compete - not justified by their performance. One of these wants to continue, but I advise him to find a cohort, because I will maintain the structure of student presentation of the course and thus he will need someone to help in the struggle, not someone who knows the answers. Kind of R.L. Mooreish, but effective.

To prepare for my interlocutorship I purchased an IBM clone, researched the materials available and found a paperback by C.H. Edwards, Jr. entitled Calculus and the Personal Computer, which met my objectives. For two intensive weeks at fourteen hours per day, I worked through this book compiling a syllabus. I had located a good DOS manual, BASIC manual and help from the Data Processing Department.

The students understood we were in this together and are going to see how the computer fits into the traditional calculus - as a tool. Some had never turned on a computer. Some had more computer expertise than I, but it didn't take long for them to realize that magic fingers and fancy menus won't solve problems. This is a mathematics course with clear objectives. Why are you turning on the computer and what for? What does the program do and how do you know it is addressing the problem? What assumptions are you making? Do you see the convergence of discrete and indiscrete Mathematics? Do you even understand the problem? Can you modify the program to solve bigger problems? It went on and on. They responded superbly, reinforced their mathematical experiences, saw mathematics they had never seen, got frustrated and in spite of all this, I still ended up seeing some fancy menus and some programming tricks!

As an aside, it is of interest to note that I invited the Physics instructor to help us through some projectile problems, resulting in a lengthy discussion with the students. We argued at great length on what the author intended and our collective confusion. A true learning experience. To get this close to what education must be was exhilarating. In addition, I invited a member of the English department to instruct them on writing a term paper on their experiences. This experience with writing across the curriculum, (WAC), raised more questions than it answered - reason to pursue! These students had never experienced mathematics education in this diverse a way even though they came from all corners of the earth - the Middle East, the Far East and Middle America.

Two major conclusions surfaced from this experience: (1) to maintain this forum for A and B students enrolled in calculus as a legitimate problems course and testing ground for student reactions to educational innovation; and (2) to let these students take their experience back to the traditional classroom as the second step to incorporation.

The third and final step will be to convince the powers that be that all mathematics courses must become computer laboratory-type courses in which the students have guided assistance to the problems assigned. Even the best students are under the illusion that if you look long enough you can find a program which, at one keystroke, will solve the problem. As the technology evolves this is certainly going to be the case. For example, to find the derivative of a function or to find the tangent line to a curve which passes through a point <u>not on the curve</u> can both be reduced to this technological solution. The latter problem, I feel, is the first non-trivial problem the student encounters in calculus, for no other reason than that they will solve the problem as if the point lies on the curve and will generate an answer, submit their solution in great confidence and think they have been duped when they receive no credit. The mathematics involved here is difficult for the student and must not be hidden by technology. As a mathematics educator I feel obliged to devote my time to the interaction of the mathematics and the technology used to solve such problems and let economy and efficiency of solution be discovered by the student rather than presented by the instruction. Yet, the instructor must maintain a watchful eye that this discovery is eventually made. This is the "art" of teaching.

A final word of caution to those convinced of the viability of the above course. No matter how 'good' your students are they will complain of the time required by such a course and may not continue in light of their required studies. This is why you must choose these students and not open it up to all comers. Furthermore, don't let the powers that be force you into making it a bigger and popular course. The bottom line in such a course is for you, as an instructor of traditional courses, to discover student responses which will facilitate incorporation of what is learned into the traditional course.

In conclusion, bring on the new technology, provided each of us mathematics educators have a clear understanding of the interaction of the technology and what we feel are the important ideas to be learned and the problems to be solved. The above is but one way to achieve this clarification.