The New Precalculus-Experiences of an Old Precalculus Teacher

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I originally got involved in the new workshop Precalculus because it seemed a natural next step. After all, the Mathematics Department decided to make the Calculus dependent on the graphing calculator, and laboratory oriented, so it was natural to make a similar change with the Precalculus course in which so many of the students were really preparing to enter the calculus. I had suggested the course modification in the past, but did not want to do this while too many people refused to require the graphing calculator. This time I taught all but one section, which was staffed by Prof. Daniel Schaal who was friendly to my ideas and both of us could require the calculators and the labs without anticipating as much student dissonance. He diverged from me during the semester but was very helpful and supportive during the semester and also afterwards.

My preparation for making such a radical change were many. I was always interested in computers. In a paper I presented to SHEMA in 1988, I spoke of what the students could do in a course like this one if we gave them some encouragement. I was always interested in encouraging students to explore and get new ideas because I think they can do it at ALL levels. At the summer experience at Allenwood they spoke about empowering the students. I did that to some extent when I taught in Group Theory using group assignments. I attended the technology workshop at OSU on calculators, and CAS. To illustrate this three students and the student grader from Precalculus solved a problem in the Spring '97 Pi Mu Epsilon Journal, and one of them, a theater major, had her solution published. Approximately 1/3 of the students were Mathematics and related majors, 1/3 Biology, and 1/3 general education. Of course the Biology were generally upper class and some very weak. It was a requirement. The Mathematics majors were those that did not place Calculus, but thought they should have, and the other majors were usually the strongest but had the least interest. I had a constant battle with those that didn't know what they didn't know and claimed they didn't learn anything.

Learning by doing activities was a new idea to many in this class, which met considerable student resistance. They wanted a boring lecture on what they already knew, not something new. What they got was laboratories/discussions, that were really active. People in the hallway would pass this class and be astounded at the activity. Just how do you form class groups? I tried to get one student in each who knew the calculator, and one Mathematics major. I think next time I should have different groups for each week, or each chapter so they get to work with more people. Some groups were predatory in that one person always did the work. One member of a sports team had the other one doing her work. I'd use more structure here and rotate assignments within the group like I've seen in many workshops I've attended.

Homework groups were the same as the class groups. I broke down problem assignments and had each group responsible for putting a problem on the blackboard. I had a grader and she did a wonderful job of doing labs and homework like a calculus student. Some were quite lengthy. She was in Calculus II. We often broke up into groups to try a Do Now Exercise, or a brief exercise on recent material.

Of course students had an array of calculators from TI83, TI85 to HP's, Radio Shack, etc. and the guts of these are all different. This meant that class could be disrupted when a student could not get their calculator to do what needed to be done.

Basic topics from Precalculus covered: composition of functions, translation of axes, graphing polynomials beginning with quadratics, graph rational functions, work with graphs of logarithms and exponents, and trigonometry. The only traditional topic lost was conics, but they appeared coincidentally, and parametric were explored in greater detail. Recursive functions also appeared. The main difference was trying to use the calculator to make life easier. Some examples of this follow. Finding roots of polynomials vs. D'Alembert is a good example of this last. We still need the theorem: q/p gives plausible rational solutions of the polynomial where q is a factor of the constant coefficient and p a factor of the leading coefficient. But the calculator tells you what root you should be using. Students have to find the regions where the roots are to be found in order to do meaningful graphing. The purpose of course is just this sort of dissonance. Mathematics isn't as easy as you think if you try to do it without the theorems.

Students found slope intercept form of a line by investigation. Most students recalled the formula and "cheated." But when they tried to find the roots of a quadratic, the example was chosen so that it couldn't just be graphed. You had to use the mathematical analysis just to know where to look to about a blank screen, or a single vertical-looking line. This problem with windows followed us through the entire course. Sometimes you would just see a piece of a curve, and would have to modify the window to see more. Sometimes you would be asked to

try curve fitting a set of points, with only minimal success, because the curve turned out to be something quite different than what was expected. Growth and decay models exemplified this. Precise answers were often not correct, and rounding the computer answer an exercise in futility. The answer might really be 4.0001. Finally, the use of parentheses was essential for the students to get anything like correct graphs from their calculators. When they did these by hand they could be very careless and still do things correctly.

Some topics that were easier to attack using the calculators included stretching and shrinking functions using parameters to supplement the traditional translations, and recursive definitions and functions, which can be programmed in or done repeatedly using the calculator. One such application is the definition of "e" using a limit approach. This approach is very useful in the calculus.

Toward the end of the course, the students persuaded me to try my hand at labs, and we did a few which involved graphing and observing such things as parametric functions.

I asked the class every week or two how we were doing and what was their impression of the course, the exercises, the calculators, the tests, everything. They were reasonably honest. They hated the text, which, though it had the right material seemed to be unreadable for them. When you get this type of feedback, you have to be prepared for it. If you goof some of the students can get quite graphic about it.

Most students seemed to do well enough in the course, a bit better than the previous year when I also taught three sections of the same course. A few more continued and actually did about the same to a bit better in a course where more that 50% failed or got D. The number of students continuing: 31+1/80 instead of 18+10/71 where the first number is the number in pure calculus and the second in applied calculus seems to be nil, but those that took pure calculus rather than applied calculus increased significantly. We do know they fared badly last year, 14 passed this time as opposed to even fewer last time. And the course was not the same--it got harder and more calculator oriented.

Student evaluations were about the same as last time. With students representing their great aversion to the text, and the experimental nature of the course, this represents a real improvement over last time. They liked calculators, real problems, and the at-ease approach. They disliked the text, the extra work, the fact that they knew it all, and the weird instructor. This compares with the spring evaluations which were up nearly 0.75 points in more traditional classes.

Getting to know students better and getting more student involvement were advantages of the course. Students know each other better, and really interacted over the material. Students could be quite helpful with the calculators as well. Resistance of students who preferred what they knew from High School and didn't want to do anything new was a problem. Many of them saw this as a waste of time because they didn't really want to be challenged, only to do well in an easy course.

My plans for the future include going to a seminar in June on Workshop Precalculus, changing texts, using computers(CAS) as well as calculators, requiring calculators, and doing more of my own labs and activities. If you do this sort of investigation, do some things I didn't do but should have: plan and outline, keep all handouts, keep a daily journal, involve others for review, recruit other instructors to do the same activities.