AN INTERACTIVE APPROACH TO ALGEBRA USING THE TI-83+ APPS
-PRELIMINARY REMARKS-

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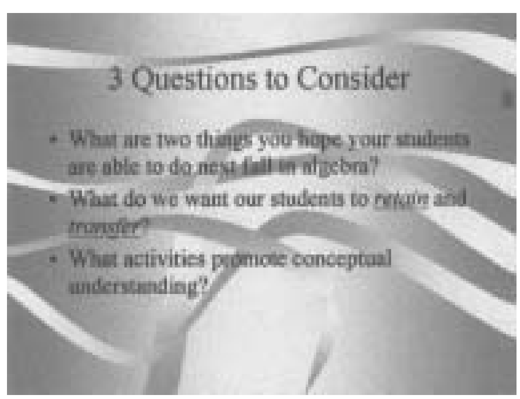
A misunderstanding of mathematics and the study of algebra exists in the general public view, so before discussing how to teach algebra in an interactive way the question, "What is mathematics?" and, particular to this discussion, "What is algebra?" needs to be considered. Many people who respond with, "Ugh! I never did understand math!" or "Thank goodness I never have to use math anymore!" have only studied the abstract, symbolic nature of mathematics and have not engaged in a personal experience with the many mathematics of life. For them, their definition of mathematics is like the seventh grader's definition, "Math is moving numbers around on paper to get the answer the teacher has." (from presentation, August, 1995, Chuck Thompson, University of Louisville) and their definition of school is like the middle schooler's definition, "School is a place where young people go to watch old people work and are graded on how well they watch!" (Ted Sizer and Jim Bohan).

Algebra is more than 'solving for x' just as elementary school mathematics is more than 'moving numbers around'. To fully appreciate the need for and usefulness of algebra, students must experience algebra in many different ways and be shown multiple examples of how prevalent it is in their daily lives. Relying on the textbook exercises is not always sufficient. Teachers need to draw from their own experiences and that of their students for realistic, everyday applications of abstract function concepts such as inverse of functions, composition of functions, parametric functions, and observing and analyzing data for extrapolation and interpolation are some examples.

Three Questions to Consider



Educators, in general, want their students to be better in mathematics because of their teaching. There are three questions that help focus emphasis on this.

What are two things you hope your students are able to do next fall (or year, semester, etc.) in algebra?
Initial responses often range from 'factor a quadratic into two binomial factors' to 'correctly plot the graph of a polynomial function'. However, if only two goals can be given, then instead of a few skills it would

be better to focus on more global goals such as having students be able to *retain* and *transfer* learning to their next encounter with algebra. Imagine what could be accomplished with the time that is now spent on re-teaching what they supposedly learned in the prior class?

What do you want your students to retain and transfer?
Although specific skills in using the quadratic formula and determining correct window dimensions on the calculator are important, conceptual understanding of the algebra of functions including data analysis, transformations, inverse functions, parametric functions, and trigonometry, are more important. In other words, the 'big ideas' of algebra concepts. The distinction between procedural skills and conceptual understanding leads to the third question.

What activities promote conceptual understanding?
Engaging activities help promote better conceptual understanding by requiring students to be active participants rather than passive listeners. Activities include asking probing questions, using more than one representation of mathematics, requiring different and varied uses of technology, and integrating mathematics with other disciplines, within mathematical topics, and with experiences outside the classroom are some examples.

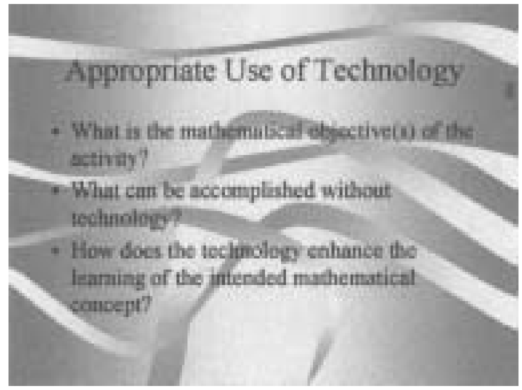
Activities that Promote Conceptual Understanding

The first activity is to <u>ask probing questions</u> such as "Why?" "How do you know . . .?" "What if . . .?" and "So what?" The last question is asked to elicit contextual understanding of the answer. Too often students give short, numeric responses that do not give a clear view of their grasp of the underlying concepts or to their ability to connect their response back to the context in which it was asked. These questions help students connect the symbolic nature of mathematics to the life-experience context of the problem.

A second activity is to <u>use multiple representations</u> of mathematics: numerical (data) view, graphical view, symbolic view, and verbal view. Realistic, everyday activities necessitate realistic, everyday approaches to mathematics. The first encounter with mathematics is through gathering and/or observing data that progresses to a pictorial and symbolic model and finally to a discussion of the scenario and drawn conclusions.

The third activity is the <u>appropriate use of technology</u>. The most important word is *appropriate*. Too often the criticisms of calculator use in the schools are a result of students' inability or reluctance to perform simple mathematic tasks on their own whether it is mental computation or drawing a graph by hand. The issue is not the calculator's role in instruction but in the manner in which the calculator are permitted to be used.

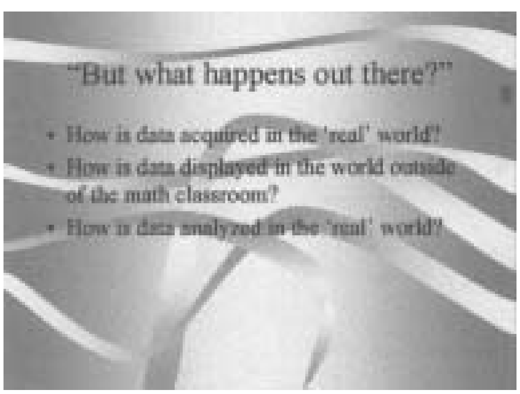
Teachers have to adjust teaching habits to accommodate students' acquisition of information available from the technology. A good thought to remember is "If the calculator is giving all of the answers, then what's wrong with the questions?" Assessment items based on the four probing questions can require students to discuss, explain, conjecture, and prove their reasoning. These assessments are actually calculator-neutral and help focus on the conceptual understanding rather than on acquisition of skills.



Another misuse of technology is to forget the mathematics of the lesson and over-emphasize the calculator keystrokes. To use any manipulative appropriately is to first determine the mathematical objective or goal of the lesson, to consider what can be achieved without the use of the manipulative, then determine how manipulative enhances the learning of the intended objective.

Finally, activities that integrate mathematics and broaden the view of mathematics help focus on what happens outside of the classroom and the textbook. Students are prone to ask, "When am I ever going to use this *stuff*?" when engaged primarily with the symbolic view of mathematics. Showing the integration of algebra with science, history, music, art, etc. is important in helping the students understand the importance of algebra in their lives. It is important to model for them how to observe algebra in the world outside the classroom giving them realistic experiences that require multiple representations of mathematics.

Asking the question, "But what happens out there?" draws the attention to how mathematics is used in realistic applications. Students are often misled into thinking that mathematics is studied only in the classroom with contrived practice problems. They can perform as mathematicians when given the task to engage in mathematics in the same way they will encounter it "out there". This can be accomplished by considering these leading questions: "How is data acquired in the 'real' world?, "How is data displayed in the world outside of the math classroom?", and "How is data analyzed in the 'real' world?" The key is to create a mathematical environment through the use of applications and projects that model the mathematics and mathematical thinking needed to accomplish the tasks.



TI-83+ Apps Examples that Model the Algebra

Activities from TI Exploration books were used to model an interactive approach to algebra:

"How Many Drivers" utilizes the Transformation Application and is in the A Hands-On Look at Algebra Functions Exploration Book which is available in electronic format only at http://education.ti.com/us/product/book/hands.html.

"A Campus Store" utilizes the Inequality Application and is available through the TI-PTE (Pre-service Teacher Education) workshop materials; contact Ed Laughbaum, www.math.ohio-state.edu/shortcourse, for further information.