

USING PALM-OS PDA'S IN CALCULUS I AND II

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The Elmhurst College Mathematics Department was recently awarded an SBC/Ameritech Partnership Award for Independent Colleges to incorporate Palm OS-based Personal Digital Assistants (PDA's) into our Calculus I and II classes. The Palm-OS based PDA comes with many features for personal organization such as a date book, notepad, address/phone list. Additionally, the Palm units we chose for our students (the Palm M130) also come with DataViz's program Documents to Go (V. 4.0) which includes word processing and spreadsheet programs that are compatible with Microsoft Word and Excel. A major benefit of the Palm in the mathematics classroom comes from the ability of the user to download (by use of a connecting cable that is included with the Palm) many free or very inexpensive programs from the internet.

We have used various other technologies in our Calculus sequences over the years, such as Maple, Derive, the TI series calculators, etc. We have determined that the PDA provides a unique level of flexibility that these other tools do not. The PDA has an advantage over the computer algebra systems on desktop computers, because the students have the ability to take the technology with them wherever they go. Its advantage over a graphing calculator is its usefulness throughout the students' entire college experience, for everything from word processing to spreadsheets to scheduling. It is also extremely easy and relatively cheap to upgrade the software; this is not true in general of many of the other technologies we have used. Because a portion of the student cost for the Palm was defrayed by the grant, all of the necessary hardware and software together ended up costing our students less than the price of the most commonly used graphing calculators.

The first program our students needed was a graphing calculator program. After considering many options, we chose a program called EasyCalc. This program is free to download and use and has been, in our experience, extremely stable. More information about this program can be found at <http://sourceforge.net/projects/easycalc/>, and the latest version can be downloaded from there. EasyCalc had all of the features we had previously used in graphing calculators in our Calculus courses. It has all of the ordinary scientific calculation capabilities, including trigonometric, combinatorial, and matrix operations. Its graphing capabilities include the ability to graph multiple functions at once, zoom in or out, set a viewing window, create tables, and calculate zeroes, intersections, extrema, numerical derivatives, etc. We found that labs and worksheets that we had previously used with the TI-series calculators could be used with the PDA without altering any of the mathematical content.

One feature missing from EasyCalc is the ability to fit a curve to data, although many other statistical features are available (calculations of median, mean, variance, etc.). Because we do not use curve fitting in our calculus classes we decided that this was not important. However, we do use curve fitting in our Business Calculus sequence and will have to use a different program if we choose to incorporate PDA's into that sequence.

The next major piece of software we needed was a programming tool. We wanted to create programs that our students could use to learn new concepts and quiz themselves on concepts they had learned. We decided to use Basic as our programming language because it is very easy to use and a program created by one instructor can be easily understood and modified by another instructor. After considering many options for programming in Basic on the Palm, we chose SmallBasic. This program is free and we have found it to be extremely stable. The website for this program is <http://smallbasic.sourceforge.net/> and many Basic programming examples can be found there as well.

An example of a program that we wrote using SmallBasic is "slopegraph." We wrote this program to respond to the difficulty many students have with sketching the derivative of a graphed function. When a student runs the slopegraph program, he or she is presented with a (somewhat randomly generated) function drawn on a pair of axes. Beneath this is blank pair of axes. The student draws the graph of the derivative (using the stylus that comes with the Palm) directly on the blank pair of axes. When the student is ready to check their answer, the "answer" button is pressed, and the program draws the correct graph of the derivative over the student's answer. We wrote other programs that treat subjects such as estimating the sign of a definite integral, transformations of functions, composition of functions, sketching a tangent line, Newton's method, and Riemann sums. These programs can be found at <http://www.elmhurst.edu/~abigailh/fa03/math151-01/pddownloads.html>

To transmit programs to the student PDA's, we used a device called the WebTarget, manufactured by TriBeam Technologies. The WebTarget is a small hardware unit mounted on the classroom wall and connected to the internet. It is a two-way infrared wireless access point station that allows multiple users simultaneously to connect to the network with their PDA's. We uploaded the SmallBasic programs to the WebTarget from our desktop PC before class. During class, the students downloaded these programs to their PDA's. The WebTarget also enabled students to use the internet and read web pages in the classroom directly from their own handheld units.

Over the spring and summer we developed many of the programs and materials for the students to use with their PDA's. This fall we incorporated the PDA into our two Calculus I sections. This spring we will use them in all sections of both Calculus I and II. We have not yet determined if we will use them in Calculus III next year. Our class sizes are too small for us to do a statistical analysis on the success of the PDA's so far, but here are some general observations from the past semester.

- Students were generally very excited and positive about getting the PDA.
- Existing labs and worksheets that we had previously used with the TI-series calculators could be used with the PDA.
- Students used their PDA's for many different uses -- keeping track of their assignments and schedules, surfing the web before class, taking notes.
- The SmallBasic programs did seem to help students understand graphical concepts such as sketching derivatives and estimating areas better than students do in non-PDA classes.
- Having the students learn simple concepts, such as graph shifting and linearization, at home with the PDA rather than teaching them during class saved class time.
- We anticipated that some students would not have a computer to back up their PDA's. We were prepared to use a classroom computer for multiple-user PDA back-ups. In practice, however, each student either had a computer or used a readily available one, such as a roommate's.
- Some students already owned PDA's and did not need to purchase a new one. We made sure to make black and white versions of our programs available that would work well with older-model PDA's.