Graphing Calculators: Discovering the Concepts in Statistics

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Graphing Calculators: Discovering the Concepts in Statistics

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Why use technology?
I had just bought a new slide rule – a really nice one – when the first hand-held electronic calculators came out around 1971. Since then, the electronics have evolved dramatically from the first scientific calculators, which I began using about 20 years ago to teach statistics. I still have my slide rule but, looking back, I don't understand how people did statistics without calculators – these courses are computation-intensive, and it seems silly now to do all that arithmetic by hand.

Statistics actually has concepts that are important to learn – without the sophisticated graphing calculators we use now, students would be sort of lost in the forest among all the trees. They can get bogged down in those computations. West Valley College is a two-year community college, from which many students go on to get four-year degrees through the California State University system or the University of California. Our faculty are generally very positive about using technology in courses. Some faculty, however, did resist the change to graphing calculators, because they wanted to focus on teaching the skills required to get the calculations, as opposed to the value of the results. But I've found that when my students aren't making those arithmetical errors anymore, we can get right from the problem to the interpretation of the results

The strategy
Adopting the graphing calculator was a fairly natural progression for me from using the basic scientific calculator. I wanted to speed up the process of doing the calculations and to increase the accuracy of the results. But the main reason for using the calculators is to allow students to use the built-in functions to compute probabilities and other descriptive statistics functions.

Students are required to purchase the calculators, and they learn how to use them as we go through the course – when we do something new, everybody gets their calculator out and we do it all together. Many of the formulas are built into the calculator, but they have to understand the concepts and know which equation to use for each problem. I will write the formula that's programmed into the calculator on the board, and then we'll do it by hand, so they get the idea of what is really going on. I still provide a "formula sheet" that shows the formulas and when to use them, and on exams they have to work with the formulas on paper and use the calculator just to do the computations, because not all the formulas are programmed into the calculator.

When we go over homework problems in class, we have discussions about them: not "How do you get from here to here?", which is all arithmetic, but "Here's what I think this means and "That's what you think it means, so let's talk about it." In testing, I ask a lot more questions about

interpreting the results – not only do they have to get the number, but they have to write a paragraph or two to put the results in context and tell me what it means.

The use of the graphing calculator for statistics is pretty much entrenched now, but a couple of colleagues and I like to think that we gave its use a big kick about 10 years ago. We got a grant from the National Science Foundation to do calculator workshops in the State of California; we traveled up and down the state giving talks on how to use the graphing calculator in various courses.

The courses

I use the graphing calculators in Math 10, "Elementary Statistics and Probability," which has 300 students per semester, and in Math 12, "Calculus for Business Majors," with about 60 students per semester. Actually, the calculators are used in all of our math courses at West Valley. Most of my students are from the social sciences – psychology and sociology – and from business. To graduate from the four-year schools in California, students are required to take one course beyond intermediate algebra, and statistics is the one that most students elect to take. It's perhaps the most useful of the math course options, as opposed to trigonometry, for example, which they may never use. At least statistics opens some doors for them. Both Math 10 and Math 12 are lecture courses, with no sections.

The learning technology

The graphing calculator I require for my classes is the TI 83, from Texas Instruments. The folks at Texas Instruments have programmed in almost all of the statistics formulas that we need. The students have to understand the problem and recognize what formula to use. Then they call up the formula on the screen and the calculator prompts them to enter the right numbers in the proper "order of operations." The calculator does a lot for you, but unless you enter the numbers in the right order, with parentheses and such, you won't get the correct result. The calculator will also display the corresponding graph for the formula; students don't need to laboriously repeat the calculations with different parameters to hand-plot a graph.

One example of how we use the graphing calculator is to construct confidence intervals. If the students want to estimate the confidence interval for the mean of a selected sample, they enter the sample mean, the sample size, the sample standard deviation, and call up the right button; the graphing calculator provides the result. It displays the Bell curve and finds the area under the curve that corresponds to the probability of an event.

To apply that to a real-life problem, say we have to figure the probability that a randomly selected cup in a coffee vending machine will fill up with 5 oz or 6 oz of coffee, when it's supposed to be filled with 8 oz of liquid. When we enter the correct values, the calculator will draw us the bell-shaped curve for that, display it on the calculator screen, and show us exactly what we need. For the real-life application of this, if the vending machine company comes out, takes a sample, and their sample mean varies from what it's supposed to be, the company knows that machine needs to be adjusted. It's actually a quality control issue. Moreover, we don't need a computer and statistical software package to do this kind of work anymore – the calculator does it all.

You can find out more about the TI 83 and how it's used at the Texas Instruments Website: http://www.ti.com/calc/docs/graph.htm.

The results
The time savings from using the calculator allows me to do a lot more problems in the class – we can cover a lot more material and make a lot more different interpretations. More examples allow the students to recognize and grasp the concepts.

At first it's a bit difficult for them; they have to learn statistics and learn how to use the calculator, too. But after a few weeks it's not a problem. They don't really understand how helpful the graphing calculator is until we actually go through some problems and they have to try the computations that the calculator does automatically. We haven't done any research on it, but I think the students' reaction is pretty good. Because I can show them a wider variety of problems, they get a better understanding of the many fields in which statistics can be used, instead of "Okay, we've got time for one problem." Using the graphing calculator takes much of the drudgery out of statistics and brings the subject alive for students.

If you have any questions about the use of graphing calculators, you can contact me at denny_burzynski@wvmccd.cc.ca.us.

LINKS
West Valley College: http://www.westvalley.edu/wvc/default.html
Texas Instruments http://www.ti.com/
Texas Instruments Graphing Calculators http://www.ti.com/calc/docs/graph.htm
TI-83 http://www.ti.com/calc/docs/83.htm
TI-83: Specs http://www.ti.com/calc/docs/83bid.htm
TI-83: Assembly Programming http://www.ti.com/calc/docs/83asm.htm
TI-83: FAQs http://www.ti.com/calc/docs/faq83main.htm