The Role of the Calculator in the Collegiate Math Classrooms at Bob Jones University

Driving Philosophy

The BJU Mathematics Department believes that the calculator as a computational tool has an appropriate place in the Christian classroom. As individuals created in the image of God, we are to be thoughtful about all processes and problems. As fallen sinners, we have a tendency towards laziness. Tools can enhance our ability to consider the problems around us and can also help us to get by without true understanding. This is most definitely true about the calculator in the mathematics classroom.

We believe that the calculator should never replace a student's understanding of the problem and the solution process, but should serve as an aid that helps bring insight. This philosophy will play out differently in different classes with different goals. We will consider two different categories of classes, those targeting STEM* majors (students who regularly need rigorous and advanced mathematical tools within their programs of study) and non-STEM majors (those whose regular use of mathematics and logic tends towards business or personal applications and away from technical problems).

* STEM stands for Science, Technology, Engineering, and Math.

Practical Consequences in the Classroom

For STEM Majors who interact with mathematics early and often ….

In light of this philosophy, we first consider the STEM classroom. Very limited calculator use is permitted in our pre-calculus/early calculus courses. Students are permitted to use their calculators for arithmetic and the computation of exponential or logarithmic values, but not for short-cutting the solution process of the problems in question. For instance, when the students are studying factoring, they are not permitted to use factoring capabilities that they may have in their calculators. We expect them to use the factoring theory discussed and demonstrated in class to ensure that they understand how factoring works. When students are learning to differentiate or integrate they are not permitted to use these features on their calculators even to "check" their answers on tests/quizzes (checking answers is acceptable on homework as a part of the learning process). The student is expected to understand the foundational idea of differentiation as an instantaneous rate of change and integration as an accumulation function and apply these ideas along with the theory developed in class to solve problems. Allowing the calculator to short cut this process presents two problems. First, there is no true demonstration of the problem-solving process (the actual thing we are trying to teach), and second it gives the student a false sense of understanding; for while they can (sometimes) compute an answer, they are often left with a result for which they can provide no interpretation.

We do recognize the value and need for computational tools, and because of this, we begin to allow and expect the students to use their calculators to increase the efficiency of their problem solving as they progress to more advanced classes. For example, while developing the ideas of calculus, the students are permitted to use the algebraic tools in their calculator to speed their work along. When studying multi-variate calculus, where understanding the problem and setting up the multiple-integral is substantially more problematic than solving it, we expect the student to use their calculator to compute the actual values since understanding is

demonstrated in being able to set the problem up correctly. At every point in which a decision must be made to allow or not allow a computational aid, we use the driving principle of what will help the student demonstrate true understanding to us for assessment and what will help the student develop the deepest understanding of the problems at hand.

For Non-STEM Majors who face mathematical principles in much more applied circumstances …

For non-STEM students, our calculator policy is dependent on the purpose of the course. For courses where computational accuracy is being developed and the algebraic techniques are the focus of the class, such as math for teachers courses and college algebra, the use of calculators is limited. For courses that focus on the application of computation to particular problems, such as in statistics and finance courses, the calculator (or other computational device such as Excel or SPSS) often becomes a tool to "look-up" values (such as p-values for the normal distribution in statistics or values of an exponential function in finance) or sometimes to solve problems that are computationally too challenging to be solved (such as computing interest rates in finance courses, which are solutions to *n*th degree polynomials).

Again using the tool to improve understanding of the problem and its solutions is the driving principle. It is assumed in courses targeting the non-STEM student that the important skill to be developed is the ability to understand the problem in a given situation, determine a mathematical approach to solving the problem, find a solution, and then interpret the solution in light of the given situation. Often the actual computation of the solution is expected to be done using the calculator or software package since the primary goal in these non-STEM courses is not the algebra of solution, but understanding the problem and applying an appropriate technique.

Technology Used in BJU's Math Courses

The BJU Math Department recommends the following calculators for their students based on the student's mathematical plans:

- Students who will be advancing no further than trigonometry: TI 30 or TI 83/84 or TI Nspire
- Students who will be advancing no further than Calculus I or Applied Calculus: TI 83/84 or TI Nspire
- Students taking Calculus II (or anything more advanced): TI 89 or TI Nspire CAS

No experience with a graphing calculator is expected prior to enrolling in BJU, and computer emulators are not permitted for testing purposes in BJU math classes at this time.