Teaching Philosophy

My teaching philosophy can be seen in the procedure I am following in my Calculus III course, fall 2014, at Syracuse University. The first paragraph of my syllabus lays out several levels of learning I hope the students will pass through during the course. The first step is learning specific definitions and formulae by rote, from the equation for a plane to the dreaded limit definition of the derivative. On the next level, students learn to apply these memorized nuggets of mathematical knowledge in explicit situations. They might calculate the derivative of $\frac{2xy-1}{3x+4y}$, or they might learn to follow the steps involved in maximizing a two-variable function subject to a constraint. As the basic calculations become more natural and automatic for them, they will (one hopes) also pass to a third stage of learning and develop a richer understanding of how the pieces fit together and how, for example, Lagrange multipliers and gradients encode information about the extrema of a function. Finally, one of the overarching goals of most calculus classes is for students to understand what derivatives and integrals really are to the point where they could go to a different class and encounter a new topic like the cumulative distribution function and actually see fairly quickly how it is related to the probability density function. These are the insights students really need to internalize before going on to many other math, science, and engineering classes, where they can look up formulae but cannot look up what an integral does. Related to this goal is the reason math classes are mandatory for so many other majors, too: they develop a student's ability to approach a new problem rationally, break it up into its component pieces, and analyze each in abstraction from the others.

The most basic math skills are just techniques for manipulating abstract objects. I like to compare this stage of learning to warming up with scales in music, doing drills at the beginning of sports practices, or memorizing new vocabulary for a foreign language class. We only do a few basic drills in class, but almost all of my homework assignments start with a smattering of simple problems like this and a suggestion of additional problems that students can do until the basics come naturally. One excellent resource I have used for this kind of practice is an online program called Webwork. The instructor can choose a template for each problem, and the server generates and grades unique problems for each student. The students get immediate feedback and can correct to 100%, and the instructor and teaching assistants can focus their grading efforts on less mechanical problems.

I have thought extensively about the best ways to help students develop a more sophisticated understanding of the mathematical tools they learn and how to help them advance their problem solving and analytical skills. The method that works best for me is to walk students through a problem step by step and let them try each piece on their own; if they can solve each step by themselves, they start building up good problem-solving habits much more quickly than they would watching me do the work. Even when they get stuck, they still see an example of how someone breaks down a problem, solves the pieces, and reconstructs them into a solution. For example, a Calculus I class on related rates could start with a series of problems of slowly increasing complication: *A rectangle has width 10. If its height grows by 1ft, how much did its area increase?* They can solve this without even writing anything down, and most will even volunteer the answer. *If its height is growing at a constant rate* *of 1ft/min, how is its area changing?* Easy enough, and they think about how to relate minutes and feet. *Can you write that down using derivatives?* They begin to remember they are in calculus class. I write $A = w \cdot h$ and then substitute $w = 10$, but point out that h and A are changing, so we need to leave them as variables. Then we take an easy derivative, but we notice that we use d/dt, not d/dw or d/dA; we just did implicit differentiation last week, so this is not too upsetting. We start talking about implied variables, like t, and how we would recognize something was wrong if we had taken d/dw by accident. *Now say the width is growing by 1ft/min and the height by 3ft/min. How fast is its area growing?* Most of the students still do this without assistance. Some ask questions. *Does it matter what w and h are?* Now we see that w and h are both variables, so we actually use the product rule and realize the answer depends on both variables, which surprises some. *So how fast is the area growing when $w = 4$ and $h = 3$?* They still answer this quickly. *Would have been OK to plug in 3 and 4 at the beginning, before we took the derivative?* They think the answer is obvious. *Say w is 3ft, and dh/dt is 3ft/min again. What if we messed up and used the product rule instead of plugging in $w = 3$ first?* They still think this is obvious, once they notice that $dw/dt = 0$.

These methods work for all levels of basic undergraduate mathematics and even, with some modification, for a beginning graduate course. One of my favorite classes to teach was Applied Calculus 2 at Indiana University, Bloomington, which was an elective for students in some biology or pre-med majors. The students tended to like math (or at least dislike it less than their other options), but they were often less experienced or less quick with basic math skills. The course did not require as sophisticated an understanding of the basics as, say, normal Calculus 2, but I found that these students were perfectly capable of advancing to the third or fourth levels of learning. As long as I kept the basic techniques less complicated (ex, I could use e^{3x} but not $e^{x \cos x}$), they could solve otherwise very sophisticated word problems. Best of all, most of them really seemed to enjoy the class and be proud of how much they had learned.

I also strive to improve in a number of characteristics of a good teacher implicit in the goals described above. A course should be well-organized with clear goals and a published schedule (which is followed as closely as possible). Assignments should be relevant and announced in a timely fashion, and grading should be clear and fair as well as give students feedback on how they can improve, not just on whether they are right or wrong. A good teacher needs to be available for office hours and emailed questions, and, above all, must try to remain polite and encouraging, no matter what the temptation is to be otherwise. It is important to remember that the students are, ultimately, the ones who teach themselves, but the educational system is set up (and they participate in it with this expectation) so that the teachers provide the structure and the assistance that students need to do their jobs.

Calculus III (Math 285)
Section Syllabus

Instructor: Dr. Margaret Doig, midoig@syr.edu, Carnegie 317H
Office Hours: Mon/Thurs 4:00-5:00 (or by appointment)
Recitation: see your course schedule
TA: Michael Ohanyan, mohanyan@syr.edu, Archibald 103C
Website: on Blackboard

Course Goals: This is the last course in a three-semester sequence designed to introduce you to the beauty and power of calculus and prepare you for more advanced work in math, science, or engineering. Topics include vectors, three-dimensional geometry, partial derivatives, multiple integrals, and vector calculus, as well as applications to physics and engineering. Our goals include:

- Mathematically describe and manipulate vectors, 3-D objects (including planes, curves, and surfaces), multivariable functions, and vector fields.
- Extend the concepts of differentiation and integration to multivariable functions and vector fields. Develop multivariable versions of the techniques of Calculus I and II.
- Expand critical thinking and problem solving skills to apply the given techniques to unfamiliar problems.
- Evolve a sophisticated understanding of differentiation and integration and why the given techniques work.

Student Responsibility: As an adult, you are responsible for your own education. Your TA and I are here to assist you in learning this material, but the final result will depend more on you than on us. Your job will be much easier if you attend every class and recitation prepared and on time. Take time and care with your homework and studying as both are important parts of your learning process. Ask questions and look for help regularly, before you need it, not after.

Format: We will cover Ch. 10-13 (through Green's Thm) in *Essential Calculus: Early Transcendentals* by Stewart (Thompson Brooks/Cole, 2nd edition). At the end of each lecture, I will preview the upcoming material and give you something to look up in the textbook. At the next lecture, an easy attendance quiz will test whether you are present in mind as well as body, and we will then cover the material in depth. You will practice the material with homework problems announced in class and due within the next few lectures. You will review problems and ask questions during recitation and, if you wish, office hours. There will be a quiz each week and an exam after each chapter, including a cumulative final exam.

Evaluation and Grading: In-class exams will be Sept. 22, Oct. 20, and Nov. 17, each worth 20%. The final exam will be Wednesday, Dec. 10 (time TBD), and worth 25%. Quizzes and homework will be 15%. Attendance quizzes will be used to assign extra credit. The exams and overall grade may be curved. **Do not plan to leave campus before 2:30pm on Wednesday, Dec. 10.**

Additional Information: Please read the course syllabus carefully. It is posted on the Blackboard course site and on the math department website and contains additional information on many important topics, including the attendance policy, accommodations through the Office of Disability Services, and accommodations for religious observances. Pay special attention to the section on Academic Integrity.

If you have any other request or concern related to this course, please see me as soon as possible. If we cannot resolve it, contact the course supervisor Prof. Adam Lutoborski, Carnegie 213A, (315) 443-1489, alutobor@syr.edu.