

# TEACHING STATEMENT

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Mathematics consists of a large body of interconnected ideas, and is extreme among the sciences in the naturally cumulative nature of its study. Too often, I believe this is seen as a negative characteristic and allowed to intimidate students; it can be daunting to feel that you must remember *everything* previously studied in mathematics to make it through the current course. However, this inherent structure can actually be used to advantage by the instructor. Using a little forethought and some subtle repetition, one can exploit previous lessons as a natural context in which to frame new ideas. For example, one can show how the integral of a speed function (or rate, or density) over a time interval is equal to total distance (or amount, or mass). By picking a constant speed function, the integral reduces immediately to the formula of rate  $\times$  time = distance, and the student simultaneously recognizes a familiar idea and sees how the new one is an extension of their previous understanding. This approach seems to give a more concrete and intuitive understanding of the arc length formula, for example, than the standard treatment (in terms of infinitesimal triangles) usually found in textbooks.

When preparing lectures, I have three main principles. First, I begin the lesson with a brief review of the previously covered material which is most closely related to the current lesson, so as to provide a frame of reference. Second, I introduce the new material so that it appears (as much as possible) to be an extension of something they already know. Third, I select a few key examples that highlight the properties under study, and which I can use repeatedly, and in different scenarios. I plan ahead so that I can use these examples throughout different section/lessons. This allows the students to see the new ideas on a model that is already familiar, and facilitates understanding. For example, it is possible to study almost all the interrelations between uniform, pointwise, almost-everywhere,  $L^p$  and measure convergence of a sequence of functions, using just 4 simple example sequences.

Though I am a recent Ph.D., I have been the primary instructor for several courses. Most recently, I am teaching Single-Variable Calculus followed by Honors Real Analysis, at Cornell University. Prior to this year, I taught Linear Algebra for Business twice and Introductory Differential Equations once. For each course, I prepared my own entire set of notes to complement the book (these are on my web page, the web address is in the footer below). When preparing notes, I take pains to follow the terms and notation of the text, but I also add more to the presentation of the material. I expect the students to read the book (indeed, I give very specific reading assignments), so I don't want to merely repeat what the book already says. As a graduate student, I was asked by three different professors to lecture for them on occasions of their absence (due to illness, travel, etc.). Consequently, I have also lectured briefly on Basic Calculus, Game Theory, and Partial Differential Equations. I mention this here more as an indication of my professors' confidence in my ability as a lecturer than as an example of experience.

I have been teaching mathematics to students for over seven years, in a variety of different settings. As an undergraduate, I was a tutor in the Campus Learning Center for three years. During this time, I was available for tutoring by appointment and on a drop-in basis. Also, I ran a study group in which I would present a brief talk on a certain topic, and then work with small groups as they went through a series of related problems.

As a teaching assistant (TA) for several years, I have had the opportunity to lead discussion sections on most of the undergraduate topics taught at UC Riverside, including: Single-variable Calculus, Multivariable Calculus, Differential Equations, Discrete & Finite Mathematics, Game Theory, Optimization, Set Theory, Topology, Algebraic Topology, Analysis/Advanced Calculus, Probability, and Complex Variables. I have also worked with individual students on other topics as well (including Linear Algebra, Abstract Algebra, and Fractal Geometry). With a reputation for being a “good explainer”, I often have students asking various questions about other courses they may be taking. Indeed, I have even received office-hour visits from former students who have since transferred to another school. Also, I was named *TA of the Year* for 2004-2005, and I am often visited by about a dozen students at the end of each quarter who want to know what sections I will be teaching, so that they may enroll accordingly.

During discussion sections, I cycle through the class and ask questions of the students. My policy is that one can always “pass” a question and I will move on to the next person. The point is to engage the students by getting them to take an active role in the discussion, not to intimidate or embarrass them. I find this method works extremely well, and I frequently receive comments to this effect on the course evaluations. (Speaking of course evaluations, mine are generally excellent – please see the samples posted on my web page.) The students often appreciate the opportunity for some light competition, and the chance to look good without being a teacher’s pet. Additionally, I can often learn the names of the students after the first few weeks of class, and I find this engenders a friendly classroom atmosphere.

I have also been a summer instructor for (and co-founder of) UCR’s recently introduced Ph.D. preparatory program; a seminar for students who plan to take the Ph.D. qualifying examinations. The program is a targeted study of examination topics, designed for students who may or may not have taken the relevant courses at Riverside. Consequently, short lessons are presented which concentrate key portions of the material from the course, or material that the students believe to be one of their weak points. We convinced the administration of the benefits of this program in 2003, and have had great success with it since then. I have taught the Real Analysis section three times (my web page contains some materials from this, listed under Math 209D) and the Topology section once. For each of these, I assembled several hundred pages of materials (notes, problems, hints) on the school’s web-based instructional system (Blackboard), both scanned and typeset in LaTeX. This sizeable resource is now maintained and augmented cooperatively by other students and other instructors of the summer preparatory seminars. The summer program runs for ten weeks and meets once a week for a few hours. So far, the students agree that it is very helpful. For my own part, I enjoy it as a refresher on advanced topics, and a nice opportunity to teach doctoral-level material.

Some of my fellow graduate students and I recently began the Teaching Assistant Mentor Program. Graduate students who have been teaching for a couple of years can volunteer to be mentors in the program, and new graduate students are encouraged to sign up as mentees. The mentor gets a slight reduction in teaching load, in exchange for new duties related to the training of the mentee. The mentor and mentee visit each others' discussion sections, allowing the mentee to pick up tips from the more experienced TA, and allowing the mentor to critique their protégé. Also, program members meet routinely for general questions, advice, and guidance. The aim is to improve standards of teaching in discussion sections, and to help ease recent arrivals into their new role as teaching assistants.

Computers provide an invaluable asset for instruction, in several ways. As a former web site designer, I have always used the internet to facilitate the distribution of materials to the class, and for interaction with the students. Initially, I did this through pages of my own design. More recently, I have developed fluency with the Blackboard Learning System, for disseminating materials, securely posting recent scores, and sending messages to the students. I have also developed some enduring archives of mathematical information, as described above.

Statistically, most people have primarily visual learning modality and computer-assisted lectures allow the instructor to make the material more visual and dynamic. Computers allow for deeper understanding of the material by allowing students to investigate the consequences of perturbing different parameters, initial conditions, probabilities, etc. "Playing" with an equation or system of equations provides an invaluable tool for developing a feel for certain aspects of the material, especially when the tedium of plotting is removed. In addition to Mathematica, I have used the excellent web-based ODE explorers PPLANE and DFIELD with my students (available for free on the Rice University web site<sup>1</sup>). These applets run in a browser without requiring installation, and give students an immediate feel for the relation between vector fields and integral curves. At Cornell, we use MapleTA software to ensure the students read the text before coming to class: they must answer a couple of multiple-choice questions online about the next section of the text to be discussed in lecture.

Even when I am not the primary instructor, I enjoy putting time into making additional materials for the students. Sometimes this is of a tutorial nature, like the Basic Survival Tools or Compactness Mantras that I have posted on the *Materials from courses I've taught* section of my web page. Other times, it may be a short article on an application of the material that I think might pique the students' interest; especially for Game Theory and Differential Equations. I find this particularly effective for getting non-mathematics majors interested in the material.

When it comes to course materials, I believe in making my own, but I also believe in not duplicating my efforts. To this end, I put whatever I can into LaTeX for future reuse. Consequently, my teaching materials are easily stored, revisable, and searchable. Additionally, they are easy to distribute via web or email, and I believe they look more professional. I use my Internet Marketing skills for presenting information so as to make the primary message as easy to understand (and remember) as possible.

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<sup>1</sup> <http://math.rice.edu/~dfield/dfield.html>

Whenever I type up my lecture notes, exams, quizzes, and other materials, I keep them modular so that I can use them again in new ways at later dates. My eventual goal is to collect a library of digital teaching materials from which I can readily draw. While I do not intend to give identical courses year after year (and certainly not the same tests!), there is much to be gained by collecting particularly effective lessons and problems. Eventually, this store of materials will allow me to reduce preparation time, so that I may focus on research while maintaining high-quality instruction.

Homework plays an essential role in mathematics, perhaps more so than in other disciplines as mathematics truly cannot be learned without a fully active role on the part of the student. It is a truism that mathematics is learned by doing, not by listening. Hence, I make the point to my students that the homework is not just an attempt to keep them busy, or a way to accrue points toward the final grade; it is actually the most important part of the learning process. For higher-level courses, I like to develop homework assignments as little self-contained units which guide the student through an investigation of a certain idea or circle of ideas. This is a technique I learned from one of my instructors, and I found it to be very helpful. Additionally, the completed assignments provide an excellent reference for later review. Each unit is built on a consistent theme, and explores a collection of concepts, while maintaining the general independence of the questions (so that an unsuccessful solution one problem does not prevent completion of the remainder of the assignment). For an example of this, see the Math 149A Take-Home Quiz on Memoryless Distributions, the Math 023 supplemental homework assignments, or the Math 209D (Analysis prep seminar) homework packet. These are listed on my web page, in the *Materials from courses I've taught* section.

As an immigrant, I understand the extra hurdles and challenges that must be overcome by minority students; I had to work for years to obtain my citizenship. I married into a Mexican-American family, and my wife has taught elementary school for years in low-income and economically depressed districts. Often, the students from these areas have the least qualified teachers, fewer school resources, and the lowest rates of preparation for and participation in higher education. According to my uncle Michael Aldaco, Executive Director of MESA (Mathematics, Engineering, Science Achievement, a California academic support and outreach program), Algebra 1 is by far the biggest obstacle for disadvantaged students. From personal experience teaching and tutoring entry-level mathematics courses, I understand the extra work required to help diversity flourish. For example, the current Latino population of K-12 schools in California exceeds the Caucasian by a factor of 6. However, data from 2000 indicates that 62% of Latinos do not have a high school diploma and 88% do not have a college degree, as opposed to 8% and 52% for Caucasians, respectively. This is a crisis, and requires that institutions of higher learning fully support those minority students who do make it to college.

I look forward to further opportunities for teaching, as there are many things I would like to work toward. In particular, I would like to incorporate more presentations on the part of the students, as it really forces one to understand the material thoroughly, and has the side benefit of giving valuable experience with public speaking; especially for presenting technical material. This semester, I have students take turns presenting problems from the homework on Fridays. Next semester, I plan to have students from the Honors Analysis course give short presentations on specific topics of their own interest.