

## TEACHING STATEMENT

MELVIN LEOK

I am enthusiastic about interacting with students, and take pleasure in watching them grow in understanding under my mentorship, but my primary goal is to convey the sense of joy and satisfaction that comes from taking intellectual ownership of the learning process by exploring and discovering new ideas. Additionally, I aim to communicate the importance of unifying concepts that bridge various fields, since cross-fertilization of ideas is fundamental to the interdisciplinary approach that permeates modern thought.

Mathematics courses are often criticized for being boring and irrelevant, but as any professional mathematician knows from personal experience, mathematics as a subject is beautiful, exciting, and unreasonably effective in applications. How then should we convey this in our courses? Perhaps the first question to address is what is the added value of attending a lecture, as opposed to simply reading the textbook. In teaching an introductory service course, it is unrealistic to expect students to be automatically motivated and enthusiastic. Motivating examples need to be realistic, convincing, and relevant. A half-hearted toy example only sends the message to students that what they are about to learn is of purely theoretical interest.

The individual threads of knowledge that we convey in our lectures need to be anchored by prior experiences and learning, and woven into a tapestry of understanding. Therein lies the value added in having a professional mathematician teach introductory mathematics courses, that by illuminating the connections between apparently disparate areas of study, we are able to offer students a glimpse of the bigger picture, and in so doing inspire students to draw upon their full body of mathematical knowledge in approaching problems, as opposed to narrowly compartmentalizing what they learned in individual courses.

An essential aspect is the manner in which one structures the material presented in a course. Knowledge has an intrinsically hierarchical and modular structure to it. Mathematical theorems typically have the structure of a tree, where the main theorem depends on a number of subsidiary propositions, which may in turn rely on lemmas. The traditional approach to presenting a theorem in class is via a depth-first tree traversal, where one first establishes the basic lemmas, proceeding to the propositions, before finally arriving at the theorem to be proven. Such a depth-first approach to conveying mathematical content stems from a constructivist and method driven approach to mathematical education, which is fundamentally at odds with the mindset that science and engineering students bring to our service courses.

In service courses, a problem or goal driven approach to presenting the mathematical techniques is most likely to be effective. By motivating the mathematical content with a judicious choice of examples and applications that arise in physics and engineering, one is naturally led to stating the main mathematical results that are relevant to the problem at hand, which in turn entails adopting a breadth-first approach, with an emphasis on the big essential ideas early on, and delving into the more technical details only after the motivation and overarching intellectual framework has been firmly established. At its heart, the most important aspects of mathematical literacy in non-mathematics majors are logical and deductive reasoning, and the ability to abstract, which allows one to see the commonality and unifying structure in apparently disparate problems. As such, the breadth-first approach serves an important pedagogical role, by emphasizing the high-level connections, as opposed to technical proficiency in performing computations which are easily forgotten, and increasingly obsoleted by modern mathematical and scientific software tools.

These issues are paramount in lower division calculus and differential equations courses where it is essential to convey to students the fundamental role mathematics plays in other scientific disciplines. Studies suggest that the inability to establish this connection between mathematics and applications with social impact and relevance lie at the heart of our recruitment and retention woes, particularly of women and minorities. My background in engineering and physics makes me particularly effective at making these connections explicit.

In teaching numerical analysis to a cohort consisting predominantly of engineering students, one is provided with an excellent opportunity to clarify to students the important connections between the particular

needs of an application area, the mathematical analysis of numerical algorithms, and the implementation issues. For example, the application area determines the quantities that need to be estimated from a computational model, and the accuracy requirements, which in turn affect the modeling and numerical approximations that are acceptable to render the computation tractable. In addition, implementation issues play a critical role in deciding the kinds of algorithms we adopt.

I believe that enthusiasm is contagious, and that students will rise to the challenge if they believe that their instructor is sincerely concerned about their understanding. I have been described by students as “a nice teacher, and willing to help,” as well as “very approachable, and concerned that students understood the material.” This perception has allowed me to overcome the hesitation of weaker students to attend office hours, and ensure that these students receive the additional and individualized attention they require.

When presenting proofs, I adopt the breath-first approach by first sketching out the logical structure of the proof. This introduces, by example, the divide and conquer approach to problem solving. Emphasizing the logical structure of the material provides the students with the necessary mental scaffolding to build a deeper understanding. By breaking up the proof into smaller steps, students are often able to provide the details involved in each step, thereby engaging them in the process, and increasing their fledgling confidence in their mastery of the material. Appropriately chosen counter-examples to a theorem, that illustrate what goes wrong when specific hypotheses are violated, give students a better sense of the critical ideas involved in the proof, and allow them to develop the insights necessary to independently approach the problem.

In contemporary engineering, the most efficient processes are intrinsically at the brink of instability, and it is only with feedback control that these processes are stabilized. An analogous situation arises in teaching, as we thread the thin line between challenging and overwhelming our students. The key to achieving this is by periodically checking throughout the lecture that students understand, and adapting the pace and presentation as appropriate. Student understanding can be gauged by direct questioning, but more accurately by paying attention to non-verbal cues like their facial expressions. This approach is well-received by my students, who cite my ability to adapt the pace to their needs as one of the strengths of the course.

Computational labs provide a rare opportunity to observe students first hand while they are grappling with conceptual problems, which can otherwise be difficult to detect in a large course setting. This is particularly true with students from cultures that are more deferential to teachers, as it can be difficult for them to approach the instructors for assistance during office hours or after class. As such, these labs provide an opportunity for instructors to deal with a student’s conceptual stumbling blocks before they become critical.

I would enjoy teaching lower division courses on engineering mathematics, differential equations, linear algebra, and calculus, and would incorporate concepts that are not traditionally covered, but are of importance in numerical computation, such as the condition number of a matrix in linear algebra and its relation to the accuracy of iterative solvers. I would offer reading courses and individual student projects in current research topics that are not serviced by regular courses. Providing these opportunities for students to explore their individual interests will aid in efforts to improve the recruitment and retention of students in mathematics.

Teaching courses in differential geometry, mechanics, scientific computation and numerical analysis, at both the graduate and undergraduate level, would also be of interest to me. I aim to introduce modern topics like geometric integration to numerical analysis classes, and incorporate the computational aspects of mechanics into advanced courses on modern and geometric mechanics. Courses should reflect the rich interplay between the geometry, physics, and numerics in many problems of engineering interest.

At Purdue, I have taught the graduate qualifying examination courses in differential geometry and numerical analysis, and an advanced graduate topics course in geometric numerical integration. I modernized the treatment of the differential geometry course by also discussing the applications to geometric mechanics, and this resulted in record course enrollment and retention of both mathematics and engineering students. AT UCSD, I taught the graduate geometric numerical integration course using a project-focused format.

In the longer term, I would like to introduce a capstone course for applied mathematics students modeled after the Oxford Study Group with Industry, the PIMS Industrial Problem Solving Workshop, or the Harvey Mudd Mathematics Clinic, that address the solution of real-world industrial problems through an innovative blend of theoretical and numerical methods, in a group environment. Indeed, this serves as the cornerstone of the educational component of my NSF CAREER Award.

## COMMENTS FROM TEACHING QUESTIONNAIRES

Very clear and a professor that truly understands what he is teaching.

Very accessible and easy to approach.

Knows the material quite well and explains in detail. Always willing to answer questions.

Leok is interesting and tries to be humorous which is cool, makes the information less tedious.

The professor shows concern about the students' learning. Has good interaction with students and tries to inject humor into his lectures.

I really recommend this teacher! He is really funny and nice. The way he teaches is really easy to understand.

He's a good-humored guy who is clear and knows what he's talking about. Sometimes he makes inaccurate assumptions about your knowledge in some areas, and resultantly goes too fast over some axioms.

The Professor is very good, and shows incredible concern about students learning compared to many other professors at UCSD. The professor is very fair and I would highly recommend Professor Leok!

Professor Leok was an excellent teacher. He was dynamic as a lecturer, and clearly knew his stuff. Moreover, he was a great guy who the students could relate to.

Overall, an excellent course! Well taught, and very applicable! Will do!

HWs covered lecture material very well. Office hours were also very useful. Leok is a cool guy and deserves a raise.

The (extra) office hours were really helpful. & the review sessions were very focused, which was very beneficial. E-mail correspondence was amazing. & saved our homework grades.

It was really nice that we were able to email you questions about the homework and you would respond so quick. I also liked how the homework counts for a large majority of our grade since they took a lot of time and effort.

Very fair w/ grading, understands that sometimes it takes longer for some students to grasp the concepts.

I feel like he actually cares that we learn.

Prof. Leok did an excellent job teaching this course. His explanations were clear, and he made himself very available outside of class. I would very much like to take a course from him in the future.

I really enjoyed the course. The material was interesting and the presentation was clear, concise, and easy to follow. I was not very fond of the book, but the lecture notes made up for this.

Melvin is THE MAN!!

Seriously though, the instruction was excellent.

Melvin's lectures were very clear and they actually contained the material needed to do the homework, something I really liked.

Melvin was also very approachable and concerned that students understood the material.

Instructor was very accommodating to students with conflicts during his office hours. He would sit and help students past office hour time.

Overall, this course was well-taught.

I feel that the material was interesting & relevant.

I feel that Prof. Leok taught well & covered important topics in the course.

The lecturer explained materials well and explained hard-to-grasp concepts in multiple ways during the lectures which helped me understand the material better.

I appreciated the job you did with this course.

I like your teaching style, and the pace at which you covered material.

I really loved your class. Thankyou

for being a great lecturer.

You were a very good teacher. I would take another class from you because you actually cared about how each student was doing and always offered help.

He was very well prepared for class and helpful during office hours.

## SAMPLE STUDENT EVALUATIONS

University of Michigan  
Math 371 - Numerical Methods for Engineers and Scientists

Item	Course Median		College Median	
	Winter 2005	Fall 2005	Winter 2005	Fall 2005
Overall, this was an excellent course	4.00	4.06	3.93	3.95
Overall, the instructor was an excellent teacher	4.31	4.64	4.16	4.16
I learned a great deal from this course	4.04	4.19	4.00	4.00
I had a strong desire to take this course	3.27	3.43	3.50	3.43

(Maximum score = 5)

Purdue University  
MA 266 - Ordinary Differential Equations  
MA 562 - Introduction to Differential Geometry and Topology  
MA 366 - Ordinary Differential Equations

Item	MA 266	MA 266	MA 562	MA 366
	Spring 2007	Spring 2007	Fall 2007	Spring 2008
Overall, I would rate this course as:	3.9	3.8	4.1	4.1
Overall, I would rate this instructor as:	4.2	3.7	4.6	4.3
My instructor was well-prepared and organized in class	4.7	4.3	4.8	4.6
My instructor gave clear and helpful explanations	4.6	3.9	4.7	3.8
The course increased my mathematical understanding	4.0	4.0	4.7	4.2
The course increased my interest in mathematics	3.4	3.5	4.9	3.9

(Maximum score = 5)

University of California, San Diego  
MATH 20D - Introduction to Differential Equations  
MATH 170A/B - Introduction to Numerical Analysis

Item	MATH 20D	MATH 170B	MATH 170A	MATH 170B
	Winter 2010	Winter 2010	Fall 2010	Winter 2011
Recommend Class:	88%	88%	76%	100%
Recommend Instructor:	87%	100%	72%	100%
Displays a proficient command of the material:	4.60	4.75	4.27	4.88
Instructor is well-prepared for classes:	4.59	4.62	4.35	4.75
Learned from Course:	4.26	4.25	3.68	4.67

(Maximum score = 5)

MATHEMATICS, UNIVERSITY OF CALIFORNIA, SAN DIEGO, 9500 GILMAN DRIVE #0112, LA JOLLA, CA 92093.  
E-mail address: mleok@math.ucsd.edu