Teaching Portfolio

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1 Teaching Statement

My approach to teaching mathematics is to simultaneously give students difficult problems while encouraging and supporting them in their struggle to complete those problems. It is important to simultaneously challenge and support students in order to help them succeed. Additionally, inspiring students through my appreciation of the material engages more students and assists in their learning. I like using examples with which they are familiar, often from physics courses, to help them visualize why they are learning "the math" through physical examples. For example, see the attached lecture notes where I reference a problem most students had previously seen in physics. I really enjoy helping my students through their struggle to understand new concepts because once that "lightbulb" turns on they are relieved and excited, and that excites and encourages me to help more students. **I want to teach because I want to continue to improve my ability to help them succeed.**

The moment that started my interest in mathematics and science was before I was ten years old. I attended an "Expanding Your Horizons" conference at Humboldt State University, and there was a woman who pulled me out of the classroom and told me I should go into science. I found that I was good at mathematics; when I was in high school I had a teacher who was very passionate about helping us choose our future and encouraging us to explore mathematics. He advised me to major in mathematics when I applied to colleges because he felt that I had the aptitude for it. I work to pass along that same passion to help others realize their potential in mathematics. The faculty at UC Merced have inspired my teaching style, and helped me learn what our students need. UC Merced students are extremely diverse (see statistics below), and primarily first generation college students. These students, as I discovered, often do not have the same support that my friends and I had in college. I found that they often benefit from the support of their instructors. I support them through encouragement and honest belief in their academic potential; mutual trust and respect is vital to their success.

Students often assume that there is a 'gift' to succeeding in mathematics, and they should learn that persistence is more important than talent. When students conquer a difficult problem or concept it reinforces the trust they have in their abilities, and helps them realize that when a problem is challenging it is not impossible. I firmly believe that all students who walk into my classroom are capable of learning, and even excelling, at the material in my course. My job is to do my best to help them realize it. While I have served as a lead instructor and as a teaching assistant, I found that telling an individual that they can do a particular problem is often enough to push them through a barrier. While they are often surprised by the statement, they also internalize that message and perform better. I work to inspire students to believe in themselves and put forth the effort to excel in their work. For example, when I teach a concept I find particularly fun, I often dance about the room excitedly while describing it. The students are often thoroughly entertained, and that impresses on them the importance and beauty of the concept. I also noticed that many students apologize when they ask me a question, and as a response I've developed a preemptive request for students to ask me questions. Somehow our students, and even myself as a student, are too often afraid of asking questions. I approach this by responding to questions with excitement, and giving any question I receive my full attention by repeating it and making eye contact with the class as I respond. I've found that acknowledging the class members directly has had the most positive response from students.

One of the questions that seems to hold students back from engaging fully comes from the question "will I ever use this again?" I feel it is important to teach our lower division calculus classes with applications to the majors that compose our student body. Engineering majors, for example, far outnumber the mathematics majors enrolled in our calculus courses. If our students don't recognize how each concept is useful to their future, we as educators need to show them. The most efficient way to answer that question is to show examples from the fields that our students are studying. When I was lead instructor for vector calculus, I was reviewing for an exam and after I listed off the topics on the exam a student raised their hand and asked how these subjects were relevant to their major. I responded by listing cases where the concepts were used, not just for his major, but for any of the potential majors in the room (engineering, physics, mathematics, and computer science). The students were quite surprised by how these concepts were going to be used later, and that awareness gave them a reason to study the material rather than "cram" for an exam. Additionally, it brought the issue to my attention and, after discussing it with multiple students, I knew it was an important factor in their approach and their learning. I believe more students would take a greater interest in mathematics if they recognized its importance in their current majors.

Teaching mathematics requires the ability to connect with students from a variety of majors and provide an environment that helps them feel comfortable with the subject. In addition, the ways to create this type of environment are constantly changing and adapting as our students and the technology used in the classroom change over time. Thus, it is vital to spend time working in the classroom with these students. I have served as a teaching assistant nearly every semester in my graduate career, and I have also worked to develop my teaching skills in a variety of our lower and upper division courses at UC Merced. Through this teaching experience, I have also developed a more versatile style because the variety of students in our classes requires versatility in my examples and explanations to reach as many students as possible.

When I came to UC Merced to begin graduate school I also started as a teaching assistant for Differential Equations and Linear Algebra. All first year graduate students participate in a course that focuses on teaching us how to be effective teachers. Through this course I learned about different learning styles and how to effectively teach to multiple learning styles and increase the number of students learning in my classroom. For example, the typical lecture involves only written and auditory learning, whereas the visual and hands-on learning is lost. At UC Merced they have worked to include hands-on and group learning in discussions, and encourage faculty and staff to teach with visual learners in mind. Our peers and faculty sat in on some of our discussions to give us feedback, and this helped me to develop my teaching philosophy and style. More recently, I asked for the opportunity to be a lead instructor for one of our courses. My advisor took a sabbatical in Spring 2012, and I was granted the opportunity to teach Vector Calculus. I was really excited to teach, and as the semester began I found out exactly how much more work is needed from the instructor than the teaching assistants. **It confirmed for me that I really do *want* to teach.** I came away from that semester with ideas for future classes, and a base of notes which I could use to build on in the future. For example, I will definitely use 3D graphing software for vector calculus because students need the visual combined with the drawing to fully understand the 3D plots.

I enjoy the dynamic nature of teaching. We have new students every semester, and new questions. Additionally, students' questions help to extend my understanding and ability to explain the material, and they educate me about students' motivations and interests. I enjoy discovering new ways to view the material through the eyes of these students, and the challenge in adapting to meet their needs. I look forward to learning more from future students, and helping them to find mathematics as interesting and enjoyable as I do.

1.1 University of California, Merced Student Statistics

I have been very lucky to teach at a university like University of California, (UC) Merced. UC Merced has had over 50% first-generation undergraduate enrollment every year it has been open. In Fall 2013, our undergraduate population was 62.1% first-generation students and our incoming freshmen were 68.7% first-generation students. More information can be found here: *http://ipa.ucmerced.edu/student.htm*. Additionally, we are lucky to have an ethnically diverse student body. Our enrollment in Fall 2013 was 43.9% Hispanic, 25.3% Asian, 15.2% White, 6.3% African American, 4.1% two or more races, 2.9% International, 0.7% Pacific Islander, and 0.2% American Indian (1.3% Unknown). While these numbers are not ideal, they do reflect a student body that is not predominantly white. Teaching at UC Merced has given me a fantastic and unique opportunity to improve my teaching abilities with a diverse student body.

2 Teaching Experience

- **Lead Instructor**: University of California, Merced
  Duties: Prepared lectures, homework, and quizzes each week, prepared three midterms exams and one cumulative final exam, proctored exams, held two office hours each week, and managed two teaching assistants

  Vector Calculus, January 2012 - May 2012

- **Teaching Assistant**: University of California, Merced
  Duties: Lead multiple discussion sections each week (some in labs), held two office hours per week, and graded homework, quizzes, and exams.

  Differential Equations and Linear Algebra, August 2007 - December 2007

  Vector Calculus, January 2008 - May 2008

  Calculus I, June 2008 - August 2008, additional duties: prepared all discussion worksheets and quizzes

  Numerical Analysis I, August 2008 - December 2008

  Introductory Physics II for Biological Sciences, January 2009 - May 2009

  Calculus II, June 2009 - August 2009

  Numerical Analysis I, August 2009 - December 2009

  Numerical Analysis II, January 2010 - May 2010, additional duties: held 3 lectures

  Vector Calculus, January 2011 - May 2011

  Vector Calculus August 2012 - December 2012, additional duties: held one lecture

  Partial Differential Equations January 2013 - May 2013

  Calculus II May 2013 - Present

- **Assistant Facilitator**: B A STAR program
  Duties: Set up, tested, and lead labs every week, graded assignments, held help sessions for students on course work, and submitted grades and comments to the program director.

  Teaching Assistant for Physics courses, June 2007 - August 2007

3 Student Evaluations

This section contains a summary of my student evaluations from the past few years at UC Merced. The form in which these evaluations are taken is described here:
http://accreditation.ucmerced.edu/files/public/documents/Portfolio/Exhibits/Exhibits_S3 /evaluation_of_instruction_e-notebook.pdf

Complete copies of evaluations are available upon request.

Summary of Student Evaluations

This section provides a summary of numerical scores from student evaluations I received at UC Merced. All scores are on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree). I received high marks, as my average overall between the three semesters is 6.

Table 1: Numerical Scores from Student Evaluations (1-7)

	S2012	F2012	S2013
Overall Average	5.2	6.3	6.4
This instructor was effective overall	4.5	6	6.3
The instructor's explanations were clear	4.2	5.7	6.1
In this class, I was treated with respect	6.3	6.6	6.5
Materials used in this course, were useful	5.1	6.3	6.5
Assigned work was valuable to my learning	5.3	6	6.6
This class was well organized	4.9	6	6.4
I knew what was expected of me in this class	5.4	6.3	6.5
The instructor was well prepared for class	5.1	6.6	6.4
There was sufficient time in class for questions and discussion	5	6.6	6.3
The instructor displayed enthusiasm for the material	6	6.3	6.4
Methods of evaluation in this course were fair	5.4	6.3	6.1
Feedback on my work was valuable to my learning	5.3	6.4	6.1
The instructor was available for consultation outside class	5.8	6.3	6.3
I learned a great deal in this course	4.9	6.6	6.4

Selected Student Comments

This section provides a selection of student comments from student evaluations I received at UC Merced. I take students' evaluations of my teaching very seriously. I consider all the comments I receive, and add to my future courses. For example, one of my early semesters as a Teaching Assistant at UC Merced, I received comments asking me to review the material at the beginning of class. I have made an effort to review all material covered between my discussions at the beginning of class every week. Once I started doing this, I received positive feedback in my evaluations about the reviews and have received far more questions from my students about the material than I had previously. I've gotten the request for easier quizzes, and I interpreted this appropriately as a request for quizzes more similar to the examples in class (both lecture, and the previous discussion). I received better feedback from my students once I modified the quizzes and/or notes to reflect similar problems from week to week. In response to the request for more visual/computer examples, I did a lot of research into applications I could use to prepare 3D plots and similar examples before class to share with the students. I purchased the software and adapter to run these applications as efficiently as possible during my guest lecture the following semester, and the students received a much better visual of these examples. I work to improve their experience, and I modify my approach to meet the needs expressed in the student evaluations each semester.

What do you like most about the course and instructor?

"Her notes were very useful in trying to do the homework. I liked being able to see other examples other than the ones we do in class." - Spring 2013

"I liked the clarity of the explanations that were given, and the positive atmosphere of the class." - Spring 2013

"The course was taught well by both the lecturer and by the TA. I enjoyed coming to both sections and felt that the Shelley, the TA, was well prepared and ready to answer any questions. She was also readily accessible outside of class as well." - Spring 2013

"She would try to explain things in multiple ways." - Fall 2012

"Very clear, she almost never said 'I don't know'. KNOWLEDGEABLE" - Fall 2012

"The course was a very challenging course, but she made it fun to learn it and her class was not boring. I liked her enthusiasm for the material and how she tried to use real life examples for us to be able to make a connection. She was easy to approach and answer questions until one understood and during class she would try to give different explanation of what the student had asked her if student still did not understand." - Spring 2012

"She indicated real life applications for the material." - Spring 2012

"She is very enthusiastic and passionate about the material. She actually cares about our learning. She gets to know her students and is very helpful when needed." - Spring 2012

What could the instructor do to improve the course, if anything?

"I think more practice examples could be posted online. Otherwise, I think the instructor is doing a great job!" - Spring 2013

"More examples. Easier quizzes." - Fall 2012

"She should include visual/computer representations for the beginning of course material so that students can better understand what is going on." - Spring 2012

"Though I liked her challenging problem because it made the test seem easier I would like for her to post the answers of the test like problems after we have turned them in so that we can know what we did wrong." - Spring 2012

Additional comments

"I was expecting Kim, Arnold to teach the class. I was upset at first, but quickly started to enjoy the class. Most students had a problem with this so I feel like it had an impact on their learning and how they view Shelley. People were comparing her to Kim and you cannot compare to individuals. They both have different styles of teaching and different amount of experience."

4 Teaching Samples

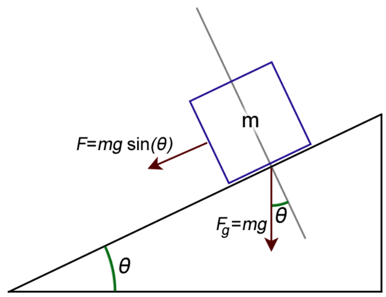
The following notes and homework are from the Vector Calculus course I taught as lead instructor in Spring 2012. This came from the middle of the semester when I felt I had adjusted to write for the students and worked to include examples relating to real applications and other course applications of each concept. The section shown is on partial derivatives. The homework for this class was a combination of book problems and problems written by me to prep students for my exams. I attempted to touch on each concept from the section covered when writing problems for their homework. Here, I have shown the full homework assignment even though there is only the lecture on partial derivatives. All book problems were chosen from the textbook *Calculus 7*, by James Stewart.

Sample Lecture: Vector Calculus, Partial Derivatives

Given $f(x, y)$,
If you take a derivative with respect to x, $f_x(x, y)$, y does not affect change in x and is therefore treated as a constant.
If you take a derivative with respect to y, $f_y(x, y)$, then x does not affect change in y and is

treated as a constant.

Example: Block on an incline



if we treat mass as "x", and the angle of incline as "y", the force down the incline due to gravity is "$f(x, y)$"

Note: The force is affected by the mass of the block and the angle of the incline (we assume gravitational constant, g, also). However, the mass of the block does not affect the incline, nor does the incline affect the mass of the block.

Additionally, if we calculate $f_x(a, b)$, it is the same as some $g'(x)|_{x=a}$, where $g(x) = f(x, b)$.

Since the force as calculated in physics is $F = mg\sin(\theta)$, we can write it for this example as $f(x, y) = xg\sin(y)$.

The corresponding partial derivatives are then

$f_x(x, y) = g\sin(y)$

$f_y(x, y) = xg\cos(y)$

$f_{xx}(x, y) = 0$

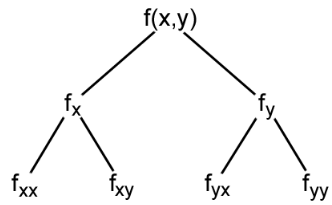
$f_{yy}(x, y) = -xg\sin(y)$

$f_{xy}(x, y) = g\cos(y)$

$f_{yx}(x, y) = g\cos(y)$

Note: Mixed partial derivatives, f_{xy} and f_{yx}, are the same here.

Clairaut's Theorem: if $f(x, y)$ and its partial derivatives are continuous on an open region, then $f_{xy}(x, y) = f_{yx}(x, y)$ in that region.



Other notation used for partial derivatives: $\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial^2}{\partial x^2}, \frac{\partial^2}{\partial y^2}, \frac{\partial^2}{\partial x \partial y}$, and $\frac{\partial^2}{\partial y \partial x}$.

Example: Calculate all first and second order partial derivatives of $f(x, y) = xe^{xy}$

$f_x(x, y) = e^{xy} + xye^{xy}$

$f_y(x, y) = x^2e^{xy}$

$f_{xy}(x, y)) = xe^{xy} + xe^{xy} + x^2ye^{xy} = 2xe^{xy} + x^2ye^{xy}$

$f_{yx}(x, y) = 2xe^{xy} + x^2ye^{xy}$

$f_{xx}(x, y) = ye^{xy} + ye^{xy} + xy^2e^{xy} = 2ye^{xy} + xy^2e^{xy}$

$f_{yy}(x, y) = x^3e^{xy}$

This extends to more variables, for example: $f(x, y, z) = \cos(xy)e^{zx}$

$f_x(x, y, z) = -y\sin(xy)e^{zx} + zcos(xy)e^{zx}$

$f_y(x, y, z) = -x\sin(xy)e^{zx}$

$f_z(x, y, z) = x\cos(xy)e^{zx}$

Partial derivatives are also used to define natural systems

$u_{xx} + u_{yy} = 0$, Laplace's Equation is used to model such problems as fluid flow, and electric potential. It has solutions which are harmonic functions, sine and cosine, etc.

$u_{tt} - a^2u_{xx} = 0$, Wave Equation is used to model travelling waves, where a is the speed of the wave. Applications in sound (acoustic waves), light (electromagnetic waves), and fluid (fluid dynamics) modeling.

$u_t - ku_{xx} = 0$, Heat Equation is used to model heat distribution over time, where k is the thermal diffusivity.

Recall Implicit Differentiation:

Before: Given $x^2 + y^2 = 1$, you could solve for $\frac{dy}{dx}$ through taking a derivative with respect to x and using chain rule.

$2x + 2y\frac{dy}{dx} = 0$, and solving for $\frac{dy}{dx} = \frac{-x}{y}$

Now: We can extend this for $z = f(x, y)$ and solve for $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ with implicit differentiation.

Ex: $x \sin(z) = y \cos(x)$

Solve for $\frac{\partial z}{\partial x}$

$$\sin(z) + x\cos(z)\frac{\partial z}{\partial x} = -y\sin(x)$$

$$\frac{\partial z}{\partial x} = \frac{-y\sin(x) - \sin(z)}{x\cos(z)}$$

Remarks on Lecture Notes

I got a good chuckle out of the students for the block on an incline example, which seemed to engage the audience well. However, I felt that I could have been more consistent in the ordering of the derivatives I calculated, additionally I feel that the choice of notation would have been better if reversed (use $\frac{\partial f}{\partial x}$ instead of f_x as an introduction). Something nice that happened during this lecture was that a student asked me to explain what an "open region" was. I had mistakenly assumed they would know because it was in the text, and I took some time to draw it on the board and explain what was meant in the context of Clairaut's theorem. In the future I would also choose an explicit example for the implicit differentiation with partial derivatives, rather than defining $z = f(x, y)$ implicitly itself.

Sample Homework Assignment

15.2 Limits and Continuity

#'s **10**, **12**, 20

Given $f(x, y) = \frac{xy^2}{\sin(x + y)}$

1. Where is $f(x, y)$ continuous?
2. What is $\lim_{(x,y)\to(0,0)}$? Does it exist?

Given $f(x, y, z) = \frac{2xy + xz - yz^2}{xy - z}$

1. Where is this function continuous?
2. What is $\lim_{(x,y,z)\to(1,1,1)}$? Does it exist?

15.3: Partial Derivatives

#'s **22**, 32, 48, **66**

Given $f(x,y) = \dfrac{xy^4 + y\cos x}{x\sin y}$

1. Find all first and second order partial derivatives
2. For what set of (x,y) does $f(x,y)$ satisfy Clairaut's Theorem?
3. Is $ln(x-y)$ a harmonic function?

15.5: The Chain Rule *Note: 15.4 will be on Homework 7*

#'s 12, **24**, **30**

Given $f(x,y) = ln(x\sin y) + e^x \cos y$
$x(t,s) = \dfrac{2t}{s}$
$y(t,s) = ts^2$.

1. Calculate $\dfrac{\partial f}{\partial t}$ and $\dfrac{\partial f}{\partial s}$. Show all steps.
2. Using $z^x \cos y = ln(x\sin y)$ calculate $\dfrac{\partial z}{\partial x}$ and $\dfrac{\partial z}{\partial y}$ with implicit differentiation. (Either method)

Remarks on Homework Assignment

I selected book problems that I thought were good for quizzes in the coming week. I wrote problems that highlighted concepts I covered in lecture and I thought would be useful in studying for the exams. For example, the Partial Derivatives problems were not just calculations of partial derivatives. I specifically mentioned Clairaut's Theorem and harmonic functions because I discussed them in lecture and wanted to give the students a problem that addressed each so that they could answer these questions more easily on an exam and refer to them in future material. I would also write problems more similar to exam problems; these were written to challenge the students so that the exams would seem easier, but often students did not attempt them because they were frustrated by the challenge. However, the students who did work through the challenge came away from the class thrilled by how well they performed on exams, and confident in the material. I will work to find a balance where students are no longer intimidated by a challenge, and leave my course more confident than when they arrived. I would also implement an idea brought to me by another instructor during my professional devlopment workshop that semester: ask the students to write a problem of their own for each section and then solve it in their homework.