TEACHING STATEMENT

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1. TEACHING PHILOSOPHY

Teaching mathematics is an important part of practicing mathematics. Both preparation for lecture and helping students in office hours helps me organize my ideas better. Success in the classroom helps create success in research.

My research focus is analysis and geometry, so it is not surprising I emphasize the geometric, rather than the purely computational, aspects in teaching. Many computational parts of calculus tend to be lost on the student. The student will forget formulas and methods after the class is over, but they will more likely retain the fundamental geometric ideas.

As an example, when talking about integration, I talk about a method I learned from chemists. A typical problem for a chemist is to find the area under a "peak" on the output from an analytical machine. Before software to do so was available, standard practice was to cut out the peak with scissors and weigh it. As chemists have access to high precision scales, this procedure turns out to be a reliable method for integration. The point is to emphasize the geometric understanding of integration applied to a real-world problem. This example gives a concrete, tangible application of the concept to a real-life situation.

My philosophy is to explain a few problems well, rather than to run through as many as possible. After finishing the solution, I often go over the ideas used, and over the interpretation of the problem and its solution. I found the book by Polya [9] very useful in many aspects of my teaching. If students understand a few selected difficult problems thoroughly, then they are better able to work out other problems on their own. I encourage students to work on their own first and try to struggle through the given problems and only when completely stuck (or when they are finished and want to check their work) go talk to their friends or tutors. I try to guide students through the problem in office hours rather than give them the solution.

2. TEACHING EXPERIENCE

My students included elementary school teachers, precalculus students, business, science, and engineering undergraduates, and of course mathematics undergraduate and graduate students. I had the opportunity to teach and help students across the spectrum in many different settings. I taught at five different universities: SDSU, UIUC, UCSD, UW-Madison, and OSU. I taught courses in precalculus, all levels of calculus, linear algebra, partial and ordinary differential equations, geometry, real and complex analysis, and several graduate courses. I supervised a graduate student at OSU who finished a masters in 2017. I am currently supervising a masters student and a PhD student who will both defend their theses very soon, and one PhD student that is just starting. I am often on the thesis committee of other graduate students. In addition, I was even on the thesis committee of two PhD students at other universities (Dusty Grundmeier at UIUC, and Michael Reiter at the University of Vienna).

I taught both very small classes (4 students in a graduate class), and very large classes (300+). At both UCSD and at UW-Madison, there were several terms when I had over 500 students combined and managed an army of TAs (around a dozen at a time) who ran sections, graded with me, and held office hours. At UCSD, despite the common practice of letting TAs grade all exams, I graded exams with my TAs, so that I could better understand how the students were doing, and to better motivate the TAs.

I mostly teach in lecture-style classes. In the graduate classes, I run problem sessions for homework, where the students present their solutions, we discuss those solutions, and together we solve problems that the students did not solve or had trouble with.

At OSU I taught undergraduate classes in calculus, vector calculus, geometry, complex variables, partial differential equations, undergraduate real analysis, and graduate classes in one and several complex variables, smooth manifolds, and applied mathematics.

I gave many seminar talks to graduate students and faculty at UCSD, UIUC, UW-Madison, OSU, and other universities, and I gave presentations at many mathematical meetings. I gave talks at the local Stillwater high school math club meeting on accessible topics related to my research.

3. Free Online Textbooks and Underrepresented Groups

During the course of my teaching, I developed five freely available online textbooks. One for undergraduate differential equations [3], two volumes for undergraduate real analysis [4] and [5], a mini-course using Hermitian forms in several complex variables [6], a course for which I appeared on the list of teachers ranked excellent by their students at UIUC, and a one-semester introduction for several complex variables from a classical point of view [7], a course I taught twice at OSU. Besides my own use of these books the undergraduate books have been or are currently being used at over a dozen universities. These include, for example, Dartmouth College, University of California (Berkeley, Irvine, San Diego, and others), University of Tennessee, Iowa State University, University of British Columbia, University of Pittsburgh, University of Hawaii, and many others. The Saylor Foundation [11] is using the undergraduate textbooks as part of their online coursework. Both books are approved textbooks in the American Institute of Mathematics Open Textbook Initiative, and have been positively reviewed by the Mathematical Association of America.

A lot of the work was done in the past several years at OSU. During this time I added a chapter and several sections to the differential equations book. I revised very rough notes into a second volume of the real analysis book, and I wrote the several complex variables textbook.

One of my main motivations for developing the undergraduate textbooks is to create high-quality material available to those sectors of society (and the world) that normally do not have the resources to attend college. Web server logs show that these books have been downloaded from all continents including many downloads from the developing world, over $380\,000$ downloads in all. An example adoption of these books as standard books in the developing world is St. John's University of Tanzania, where they can locally print copies for less than \$2 a copy. This would not be possible with traditional textbooks. The books are available as print edition on Amazon (and other sellers including some university bookstores) at very low cost, and several thousand were sold, despite being free for download.

4. Courses developed

Both graduate courses on several complex variables were designed from the ground up. I did not use any other book and I designed the material to fit both the students in the course and my research so that students taking the course can begin research in several complex variables with me. My standard semester course in several complex variables [7] has been used by several colleagues from the field at other universities. As it is a topics course, it is designed to attract graduate students to the field. In that sense, it was a success. Each time I taught it, at least one of the students decided to work with me on several complex variables. The first one finished a masters, and the second is currently working on his PhD with me and is close to finishing, the third is working on a masters and will finish soon, and the fourth is just beginning PhD studies.

The real analysis course [4] has to some degree involved course development. While the topics are more standard, at least in the first semester, I believe I developed a good choice of material and presentation for the course. I based these choices on teaching various versions of the course for 8 terms at 4 different universities. For the second semester [5] of this course, volume two, there is more freedom in the choice of topics covered. I finished the second volume in spring of 2017 and

greatly expanded it in 2018. It is already being used in several classrooms, so the design seems successful.

5. Computers and Teaching

Technology and computers are useful in teaching, as long as they do not get in the way. If a problem can be worked out quickly on paper, the student usually learns more doing it on paper. Computers are very useful for visualizing ideas, but they should not completely replace pen and paper. For example, every student should be able to draw simple graphs by hand and he or she will more likely understand what the graphs mean this way. If the students *only* see graphs drawn by a computer, they might not think hard about what the picture means. On the other hand, requiring everything to be drawn by hand restricts experimentation.

I maintain a free software mathematical package Genius [2], which is aimed at basic research, experimentation, and education. I use the software in class when visualization is necessary. Most of the recent improvements to it were visualizations or computations I wanted to do in class.

I taught with and without the aid of computers. Besides using Genius, I also give class demonstrations using Maxima [8], and developed several example worksheets over the years which I use. At UIUC, I used the software package IODE [1], which is a package for Matlab or Octave.

I hired an undergraduate student from a partial differential equation class to develop SAGE demos for the differential equations textbook. The demos are on the textbook website.

I also like to use online homework systems for more computationally oriented classes. When I taught calculus (both calculus I and III) at OSU, the classes used the webassign system. Recently I started using WeBWorK [10] system for the partial differential equations, intermediate differential equations, and vector calculus classes. For the differential equations classes, this required writing many of the problems myself as the standard library did not include enough problems on this topic. The problems are now part of the standard library for WeBWorK. The students appreciated the fact that homework was essentially instantly graded with immediate feedback.

I also put together a complete set (474 problems so far) of WeBWorK problems for the differential equations textbook (available at the book website or using the Edfinity platform). Most are heavily-edited versions from the Open Problem Library, but a large proportion had to be developed from scratch.

References

[1] P. Brinkmann, R. Jerrard, R. Laugesen, *Iode—University of Illinois ODE Package*, `http://www.math.uiuc.edu/iode/`.

[2] J. Lebl, *Genius*, `http://www.jirka.org/genius.html`.

[3] J. Lebl, *Notes on Diffy Qs: Differential Equations for Engineers*, `http://www.jirka.org/diffyqs/`, ISBN 978-1706230236.

[4] J. Lebl, *Basic Analysis I: Introduction to Real Analysis, Volume I*, `http://www.jirka.org/ra/`, ISBN 978-1718862401.

[5] J. Lebl, *Basic Analysis II: Introduction to Real Analysis, Volume II*, `http://www.jirka.org/ra/`, ISBN 978-1718865488.

[6] J. Lebl, *Hermitian Forms Meet Several Complex Variables*, `http://www.jirka.org/scv-mini/`.

[7] J. Lebl, *Tasty Bits of Several Complex Variables*, `http://www.jirka.org/scv/`, ISBN 978-0-359-64225-0.

[8] Maxima.sourceforge.net. *Maxima, a Computer Algebra System*, `http://maxima.sourceforge.net/`

[9] G. Polya, *How to solve it*, Princeton University Press, Princeton, NJ, 1957.

[10] Mathematical Association of America, *WeBWorK*, `http://webwork.maa.org/`.

[11] *Saylor Foundation*, `http://www.saylor.org/`.