# TEACHING SUMMARY

## STATEMENT OF TEACHING PHILOSOPHY

Quality teaching is an important factor in university life, but not all learning takes place in the classroom. Indeed, we encourage students to attend office hours, but crucial learning also takes place through mentoring and exposure to the mathematical research community. A good teacher focuses not just on classroom instruction but on one-on-one guidance and at-large community building as well.

**Classroom Instruction.** Every student has a different learning style, so the instructor should create a diverse learning environment. Some students, for example, are abstract thinkers and comprehend theory quickly, while others require concrete examples to gain more intuition. Some feel comfortable with equations and symbols, while others are visual learners and require pictures. I try to keep all of this in mind when I lecture: I begin with an "anticipatory set" by motivating my lectures through a series of examples, then I present definitions and theorems by providing equations and diagrams, and I conclude with a survey of applications to other areas of science.

In my three years at Caltech and five years at Purdue, I have taught classes ranging from sophomore-level mathematics to advanced topics in graduate-level number theory. At Caltech in the fall of 2002 I taught "Introduction to Abstract Algebra," a course designed to introduce students to the concept of a mathematical proof. I was nominated for the 2002-2003 ASCIT (Associated Students of the California Institute of Technology) Teaching Award, an honor which is given to less than ten teaching faculty every year. At Purdue in the winter of 2005, I taught "Elementary Linear Algebra." I emphasized examples in lower dimensions, and often gave two proofs of relevant theorems – once by drawing pictures, then another by introducing rigorous definitions. The students seemed to enjoy my references to diagram chasing as "abstract nonsense"; in fact, they created a Facebook page in my honor entitled "Edray Goins is the coolest math professor." I was named a 2008-2009 Teaching for Tomorrow Fellow, an honor which "recognizes up to twelve assistant professors [...] for their demonstrated talent for teaching...."

I also believe new technology should be used within courses. While at Caltech, I helped to implement a department-wide change where each course has an on-line feedback form; for the first time Caltech students could now make anonymous comments to their mathematics instructors by the internet. While at Purdue, I posted course information including sample exams and grades via Blackboard. I also held "virtual office hours" each Thursday where I was available through Instant Messaging. Each of the classes I have taught in the past ten years has a complete set of lecture notes typeset using LaTeX; many such notes can be found on the web at

<center>http://homepage.mac.com/ehgoins/notes/index.html</center>

These notes are often quite extensive: In the spring of 2008, Jing Long Hoelscher at the University of Arizona of decided to use my lecture notes on Class Field Theory as the textbook for her graduate-level course Math 514B.

**Mentoring.** Contact with students outside the classroom gives them the opportunity to learn mathematics at a personal level. While some students attend office hours to gain a better understanding of the course content, others take reading courses. I feel fortunate to have had two undergraduates take such reading courses with me in number theory in the past four years. However, I am most proud of the undergraduate research projects I have directed.

Caltech has a Summer Undergraduate Research Fellowship (SURF) in which undergraduates pair with a research mentor for ten weeks. Students work with the mentor in designing a research proposal to be submitted to the SURF Office for review. During the summers of 2002 and 2003, I helped three students write and successfully fund a total of four research proposals; one student worked both summers. In fact, only eleven students had completed SURFs in mathematics in 2003, where two were students of mine.

Miami University's Summer Undergraduate Mathematical Sciences Institute (SUMSRI) pairs up to six students with a research mentor and graduate assistant for seven weeks. Students take background courses for the first two weeks of the program, then conduct research for the remaining time. My first group from the summer of 2004 has a paper which has appeared in the Rose Hulman Undergraduate Research Journal. My second group won a prize for their presentation at the 2006 MAA Undergraduate Poster Session at the Joint Mathematical Meetings.

Purdue University has many undergraduates with both strong technical backgrounds in computing and healthy curiosities in mathematics. I have been fortunate to work with several undergraduates on projects which blend mathematical theory and numerical computation. Alan Stephenson and I discussed how to use Purdue's supercomputing grid to classify $6 \times 6$ magic squares; he is now a computer programmer at Microsoft. Shweta Gupte and I worked on an online database to mine data for millions of elliptic curves; she presented our research at the Grace Hopper Celebration for Women in Computing in 2008. Jamie Weigandt and I conducted a senior honor's thesis which combined statistics and number theory; he was awarded a graduate fellowship from the National Science Foundation in 2009.

I used each these research experiences as an opportunity to mentor the students. I spent time teaching students how to use technical software such as Maple, Mathematica, and LaTeX; I had them practice presenting using both traditional and digital media; and I gave them homework problems which blurred the boundaries between various branches of mathematics. Through it all, I made time to give biographical stories of mathematicians, tell stories of my travels to various research institutions, and discuss the culture of life in graduate school.

**Community Building.** The most effective way to make mathematics enjoyable is to create a community in which members feel comfortable. I have had extensive experience in creating such a community by organizing the Number Theory Seminar at both Caltech and Purdue during the past eight years, and I decided to apply this experience to working with students.

From 2002 to 2004, I was the "faculty advisor" to Caltech's Undergraduate Mathematics Club. The club was different from those at other universities in that we focused on mathematical research. We would meet once a week on Fridays for lunch where we invited a speaker to come present on a topic for fifteen minutes. Presentations included a tenured pure mathematics professor discussing a joint project with a company showing an interest in Cryptology; postdoctoral fellows discussing topics ranging from Number Theory to Topology; a graduate student discussing his life as a first-year student; and even a freshman discussing his project in String Theory. Our membership included nearly twenty undergraduates, graduate students, and postdoctoral fellows from fields such as mathematics, applied and computational mathematics, computer science, and physics.

In 2009, I organized a seminar for my three graduate students in order to learn the concepts behind the Riemann-Roch Theorem. We met once a week in the winter then twice a week in the summer, taking turns to present different material. I made sure we kept a jovial atmosphere: when one student kept confusing gamma with lambda, we decided to just create a symbol and name it after him! There has even been talk about creating a T-shirt emblazoned with "Riemann Rochs!" I think it is fair to say that was the most fun any of us has ever had in a mathematics seminar.

| 2011 | Ruth and Joel Spira Teaching Award, Purdue University |
| 2008 | Teaching for Tomorrow Fellowship Award, Purdue University |
| 2003 | ASCIT Teaching Award Nomination, California Institute of Technology |

## Academic Experience

**Mathematical Sciences Research Institute**, Berkeley, California USA

*Academic Director, MSRI-UP*             **June 2010 − July 2010**

Designed and advised a 6-week research program for 18 undergraduate students. The program focused six projects: "Searching for Elliptic Curves with Rank 9", "Squares in Arithmetic Progressions", "$ABC$-Triples in Families", "Rational Distance Sets on Conic Sections", "Encrypting Text Messages via Elliptic Curve Cryptography", and "Decrypting Text Messages via Elliptic Curve Factorization."
http://www.msri.org/web/msri/static-pages/-/node/137

**Miami University**, Oxford, Ohio USA

*Research Mentor, SUMSRI*             **June 2008 − July 2008**

Designed and advised a 7-week research program for 6 undergraduate students. The program focused on finding elliptic curves of large rank having torsion subgroup $Z_2 \times Z_8$ by using a large-scale computing array.
http://www.users.muohio.edu/porterbm/sumj/2008/NT08.pdf

*Research Mentor, SUMSRI*             **June 2007 − July 2007**

Designed and advised a 7-week research program for 4 undergraduate students. The program focused on finding elliptic curves of large rank having torsion subgroup $Z_2 \times Z_8$ by using a large-scale computing array.
http://www.units.muohio.edu/sumsri/sumj/2007/SelmerStats07.pdf

*Research Mentor, SUMSRI*             **June 2006 − July 2006**

Designed and advised a 7-week research program for 5 undergraduate students. The program focused on finding elliptic curves of large rank having torsion subgroup $Z_2 \times Z_8$ by using a large-scale computing array.
http://www.units.muohio.edu/sumsri/sumj/2006/NTpaper06.pdf

*Research Mentor, SUMSRI*             **June 2005 − July 2005**

Designed and advised a 7-week research program for 5 undergraduate students. The program focused on finding elliptic curves of large rank having torsion subgroup $Z_2 \times Z_4$ by modifying an algorithm due to Nick Rogers.
http://www.users.muohio.edu/porterbm/sumj/2005/NTpaper.pdf

*Research Mentor, SUMSRI* **June 2004 – July 2004**

Designed and advised a 7-week research program for 5 undergraduate students. The program focused on finding large rational points on Thue equations by using continued fractions of elliptic integrals.
`http://www.rose-hulman.edu/mathjournal/archives/2006/vol7-n2/paper6/v7n2-6pd.pdf`

**California Institute of Technology**, Pasadena, California USA

*Director, Freshman Summer Institute* **August 2007**

Directed a 4-week program for 8 students entering their first year of college. Responsibilities included coordinating a staff of ten members, assisting two counselors, organizing four field trips, overseeing daily activities, and writing final program report in order to renew funding.

*Mathematics Instructor, Freshman Summer Institute* **August 2005**

Lectured during a 4-week program for 15 students entering their first year of college. Responsibilities included designing the course content, giving five lectures, creating worksheets, creating daily homework assignments, and leading a staff of two workshop leaders. Also gave a series of short lectures on current research in the mathematical sciences.

*Mathematics Instructor, Freshman Summer Institute* **August 2004**

Lectured during a 4-week program for 15 students entering their first year of college. Responsibilities included designing the course content, giving five lectures, creating worksheets, creating daily homework assignments, and leading a staff of two workshop leaders.

*Physics Instructor, Freshman Summer Institute* **August 2003**

Lectured during a 4-week program for 11 students entering their first year of college. Responsibilities included designing the course content, giving five lectures, creating worksheets, creating daily homework assignments, and leading a staff of two workshop leaders.

*Lecturer, Sophomore Mathematics Workshop* **August 2003**

Organized and taught a three-day residential program for 8 students entering their second year of college. Responsibilities included organizing activities for the weekend, securing a location, and lecturing on differential equations, probability theory, and quantum mechanics.

*Mathematics Instructor, Freshman Summer Institute* **August 2002**

Lectured during a 5-day program for 24 students entering their first year of college. Responsibilities included designing the course content, giving daily lectures, creating daily worksheets, creating daily homework assignments, and leading a staff of three workshop leaders.

*Lecturer, Sophomore Mathematics Workshop* **September 2001**

*Mathematics / Physics Workshop Leader, Freshman Summer Institute* **August 2001**

Ran daily workshops in differential calculus and Newtonian mechanics during a ten-day program for 20 students entering their first year of college.

*Mathematics Instructor, Freshman Summer Institute* **August 2000**

Taught a five-day course on logic and mathematical proofs for 15 students entering their first year of college.

*Mathematics Instructor, Bridge Program* **August 1994 − September 1994**

*Mathematics Instructor, Bridge Program* **August 1993 − September 1993**

**Art, Research, and Curriculum Associates**, Whittier, California USA

*Leader, GED Mathematics Workshop* **September 2002**

Presented a one-day workshop for 10 bilingual tutors preparing adults to take the General Education Development (GED) test.

*Leader, GED Mathematics Workshop* **April 2002**

**National Action Council for Minorities in Engineering**, Nashville, Tennessee USA

*Workshop Leader / Physics Instructor, Summer Immersion Program* **July 2000**

Taught in a twelve-day residential program for 86 students entering their first year of college. Responsibilities included leading workshops in both math and physics to assist with homework assignments, presenting supplemental material in both math and physics, creating worksheets and solution manuals for the discrete math course, designing the curriculum for the physics course, and giving physics lectures.

**Eastside College Preparatory High School**, East Palo Alto, California USA

*Pre-Calculus Teacher / Calculus Teacher* **August 1998 − June 1999**

**Stanford University**, Palo Alto, California USA

*Director, Carlmont-Stanford Tutoring Program* **January 1996 − June 1998**

**National Security Agency (NSA)**, Ft. Meade, Maryland USA

*Leader, Analytic Number Theory Problem Solving Group* **June 1996 − August 1996**

Lectured five hours a week for an introductory seminar on number theory.

**Purdue University**, West Lafayette, Indiana USA

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| MA 265: Linear Algebra | August 2011 – December 2011 |
| | January 2008 – May 2008 |
| MA 266: Ordinary Differential Equations | January 2011 – May 2011 |
| MA 303: Differential Equations and Partial Differential Equations for Engineering and the Sciences | August 2010 – December 2010 |
| MA 351: Elementary Linear Algebra | January 2010 – May 2010 |
| | January 2006 – May 2006 |
| | January 2005 – May 2005 |
| MA 366: Ordinary Differential Equations | January 2009 – May 2009 |
| | August 2008 – December 2008 |
| | January 2007 – May 2007 |
| | August 2004 – December 2004 |
| MA 490: Honors Thesis | January 2008 – May 2008 |
| MA 490: Modular Forms | August 2005 – December 2005 |
| MA 490: Dessins D'Enfants | August 2009 – December 2009 |
| MA 510: Vector Calculus | August 2008 – December 2008 |
| MA 553: Introduction to Abstract Algebra | January 2008 – May 2008 |
| | August 2006 – December 2006 |
| MA 598: Introduction to Sheaves | June 2009 – July 2009 |
| MA 598: Riemann-Roch Theorem | January 2009 – May 2009 |
| MA 598: Algebraic Geometry | January 2008 – May 2008 |
| | August 2005 – December 2005 |
| MA 598: Elliptic Curves | August 2006 – December 2006 |
| | January 2005 – May 2005 |
| MA 598: Elliptic Curves and Cryptography | August 2011 – December 2011 |
| MA 598: Selmer Groups and Galois Representations | August 2009 – December 2009 |

**California Institute of Technology**, Pasadena, California USA

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|---|---|
| Ma 5a: Introduction to Abstract Algebra | September 2002 – December 2002 |
| Ma 7: Introduction to Number Theory | April 2004 – June 2004 |
| Ma 105: Elliptic Curves | September 2002 – December 2002 |
| Ma 160b: Algebraic Number Theory | January 2002 – March 2002 |
| Ma 160c: Class Field Theory | April 2003 – June 2003 |
| | April 2002 – June 2002 |
| Ma 162b: Galois Representations | January 2004 – March 2004 |
| Reading Course on Arithmetic of Elliptic Curves | April 2004 – June 2004 |
| | September 2003 – December 2003 |