STATEMENT OF TEACHING PHILOSOPHY

SIMON RUBINSTEIN-SALZEDO

My primary job, both as a researcher in mathematics and as a teacher, is that of a storyteller. Mathematics, at its best, is a collection of several stories, which we begin to understand as young children, and which we continue to develop throughout our lives, or at least our mathematical careers.

In order for students to learn mathematics well, they must first realize that what they are studying is interesting, and that it does not involve any magic. Indeed, all mathematics that we know is only possible because humans have thought deeply about problems that are interesting and have followed their instincts to their natural conclusions. In short, people have spun their own stories about how mathematics works. I aim for my students to be able to do that too, on a small scale.

So, when I introduce new topics, I endeavor to explain to my students why they should naturally like these new topics, and what problems they might have cared about before that they can now tackle using their shiny new techniques. For example, when I introduce derivatives to my students, one of the main motivations I give them is that derivatives can help us approximate numbers like $\sqrt{37}$ easily, first by using differentials, and then more efficiently using Newton's method; this would be more tedious to do without calculus. Many students will have been frustrated with having to compute square roots by hand in the past, and they are relieved to learn that it can be done more easily. (If only someone had told them that when they were younger...)

The possibility of telling stories exists in all levels of mathematics. While in the mathematics departments at Stanford University and Dartmouth College, I taught introductory classes on calculus, linear algebra, and differential equations, and I have always found many opportunities to delight my students with stories. In addition, I have taught at the Stanford University Mathematics Camp, where we introduce strong high school students to abstract algebra, number theory, and algebraic topology. These students as well always look forward to my stories, and nothing could make me happier than to indulge their curiosity. I have also found opportunities to tell mathematical stories to younger students, including middle school students in summer programs. Naturally, students at summer math programs are self-selected to enjoy mathematics more than other students might and to be more receptive, but I still find that students in general do like mathematical stories.

Date: October 23, 2012.

It is only once I have told a good story about a concept that I focus on the second big goal of mathematics education: that of technical skills. Once students realize they care about a particular concept, then it is time to teach them how to do computations with it. Thus, at that point, I can begin teaching them standard ways of manipulating the objects that are starting to become their friends: how to use the chain rule effectively, for example. It is important that students not only know why we need derivatives to solve problems; they must also be able to compute them. They are much more willing to learn how to compute derivatives once they realize that derivatives are relevant to them, rather than something that the mathematics community has conspired to force upon them.

I find that there are several advantages to teaching via storytelling. As I discussed earlier, getting students interested in the subject helps in convincing them to study. In addition, when the students understand the stories that previous generations of mathematicians have thought of in order to solve problems, it helps them to figure out similar things on their own. I always tell my students to memorize as little as possible, as memorization does not generally help in solving future problems very well, and things that have been memorized quickly are also the things most likely to be forgotten or misremembered when a student is under pressure or actually needs to solve a problem. By contrast, it is less likely for a student to lose genuine understanding of a concept even under pressure.

On rare occasions, I take the opportunity to tell my students about where the stories we tell can lead in the future, giving them a brief glimpse of what to expect if they choose to continue studying mathematics. For example, linearization in calculus is far from the end of the story, for several reasons. On the one hand, it generalizes to approximation by higher-degree polynomials, which they will see when they study power series. On the other hand, approximation of complicated objects by simple ones such as linear objects shows up all over the place in the future. It is not possible to spend much time on these things given that class time is already limited and there is a lot of course material to cover, but it is pleasant for everyone to mention such things in passing from time to time so that students become excited about continuing on in mathematics.

Furthermore, the reason I and most other mathematicians enjoy mathematics is that we like the stories ourselves. Therefore, it is much easier for me to demonstrate that I am passionate about a subject when I'm explaining it in the way that I prefer to think about it myself. Students can easily pick up on my passion for mathematics when I teach in this way, and it gets them more enthusiastic about learning it themselves.

I have evidence that following my philosophy leads to great results, as my students both learn a lot from my classes and give me tremendous evaluations. Here is a sampling of comments I received from my most recent set of evaluations. One student wrote: "Simon is absolutely the best math teacher I've ever had. He's extremely

knowledgeable, and so excited to share his interest (and knowledge) about math with all of us. I learned so much from him, and became so excited to learn more about math." Another wrote (modulo capitalization and punctuation): "Simon really loves math and it showed. His passion for it made it easy to learn from him. Simon was the best section leader I've had at Stanford." Most of the other comments I received, which I shall omit here, are of a similar flavor.

So far, I have taught classes in several areas, including calculus, linear algebra, differential equations, and combinatorial games, and minicourses on algebraic topology and cryptography. Later this year, I will add probability and statistics to that list, as I am scheduled to teach classes on those topics in the Spring at Dartmouth. I am also prepared to teach classes in number theory, abstract algebra, real analysis, complex analysis, topology, and combinatorics, among others. I am excited to expand my repertoire, to develop new stories in other areas of mathematics, and to teach new students. Teaching classes is always an enjoyable experience for me, and I always work hard to make sure I do an excellent job.

I am also interested in mentoring students, and I started doing so when I was in graduate school. While in graduate school, I mentored a high school student on a research project about analysis on surreal numbers, which he has entered into some science fair competitions, and he was recently named a regional finalist in the Siemens Competition. It was a very impressive project, at the level that high school students rarely produce, and it was a joy for me to be able to assist him in it. I was also a mentor for an undergraduate summer research program. The undergraduates too did some very good work, beyond the level that I had expected. While these projects were only moderately related to my primary research interests, there are several possible projects in my area which I could use for undergraduate research projects and perhaps even high school projects. Since my research draws from so many areas of mathematics, including number theory, algebraic geometry, topology, group theory, and combinatorics, I would be able to direct research projects for students with a diverse set of interests. Furthermore, as there is a computational aspect to my research, students who enjoy programming could help me to produce interesting results. I look forward to mentoring more students in the future.

Department of Mathematics, Dartmouth College, Hanover, NH 03755
E-mail address: simon.rubinstein-salzedo@dartmouth.edu