

## TEACHING STATEMENT

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In an information-rich era, when Podcasts, YouTube clips, online tutorials, and electronic textbooks are making both low and high-quality instruction freely available, a teacher must take seriously the question “how is being in *my classroom* more valuable than the other learning opportunities available?” For me, this has been a question that motivates serious thought about the purpose of my teaching and the ways that I teach. It has motivated some of my greatest improvement thus far, and it is a driving force of my continued development.

So what do I bring to the classroom that is so valuable? I can do something effortlessly which recorded lectures and online texts can only do in the clumsiest ways: *I can interact with my students*. During class this means real-time interaction: changing the pace of my lecture depending on student response, answering questions in class, as they arise. Over the course of a semester, this means structuring our class time so that we spend more days on material with which students are struggling.

When I realized that student-teacher interaction is what makes live classrooms so valuable, I began to pay more attention to my students. When someone asks a particularly insightful question, I capitalize on it and let the class think about it before discussing the answer. When a homework problem turns out to be more difficult than I expected, I discuss it in class and use it as an opportunity to highlight the point that previously had been missed.

My most interactive classes to date were the geometry courses for pre-service elementary and middle-grade teachers. There, the focus is on both learning and learning how to explain. Each day involved in-class activities around either student presentations of explanations they had worked out as homework, or small group discussions about different ways to understand and then explain new concepts. When we returned from these activities, I could use the high and low points of the activity as a rhythm for the next part of the lecture. After watching the students explain different ways to determine triangle areas by basic geometric reasoning, I could give a custom-fit introduction to different ways to think about parallelogram area.

When I teach an upper-level undergraduate course, I use my interaction with students to find ways of challenging them particularly to capitalize on their previous successes. When I taught point-set topology—with a relatively small number of students—I set aside one day for each student to give a lecture at the end of the semester. In this particular class, the students had been learning successfully as a single group and I wanted to see them take ownership of their success through individual projects. I met with each one to choose a topic together which they would be able to learn on their own; then we met a couple more times to discuss what they planned to present, and how they would present it. Based on student reactions and the course evaluations, these were the most challenging and most satisfying assignments for them.

In Calculus III, students have a hard time adjusting to the idea of three-dimensional regions. After drawing several myself, I give the students time in class to work in small groups. The students help each other with the critical visualization, and I can interact with them more freely as they ask about specific aspects of their problems. I give each group a different problem to work on, and when they are finished I ask each group to spend 5 or 7 minutes presenting the region from their problem to the class: how they visualized it, and how they determined the limits for integrating over the region.

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## EXTRA-CURRICULAR TEACHING

One of the things I love about mathematics—which I love showing to my students—is that even the most elementary topics have points of contact with topics that are far more complex and beautiful and intriguing. I bring these up in class when they are appropriate and when we have time, but this is not always possible. I also want to inspire students that they can investigate such things for themselves: This is a purpose for which online resources are particularly well-suited.

Several years ago I began the “Fun Topics” section of my website with this goal in mind. I was teaching Calculus II at the time, and students had been asking if there was any relationship between the ordinary trig functions and the hyperbolic trig functions, which we were just learning. “There is,” I told them, “and you’ll never guess what it is!” I told them that we would be developing an idea later in the semester (Taylor series) which would allow us to understand the relationship. When the time came, I brought this question up again, gave a short tutorial on complex numbers, and explained the connection through Euler’s formula (which is easy to motivate with Taylor series). This took about 10 minutes, and then I pointed my students to a page on my website where I had written more, included pictures, and added some links for additional information.

That class was a great one for additional topics, partly because the material is so novel and partly because the students were genuinely intrigued by the idea of infinite sums—how thinking mathematically about the infinite changes our intuition about shapes and numbers. I developed short Fun Topics around things like the Cantor set, Gabriel’s Horn, and the Banach-Tarski Paradox.

I found that once I had started writing additional topics, adding more was irresistible! There are now sections for Calculus I and II, and for Elementary Geometry<sup>1</sup>. Each item describes something connected with a topic from class. I make brief mention of it, and leave it to students’ curiosity to learn more if they want to. With resources like these, I show students some of the excitement of working in mathematics: *the tools of mathematics give one insight into a world that can hardly be imagined without them.*

One of our local elementary schools invites professionals from the community for a “career day” every year, and this is the theme I tell students about at the math table while I demonstrate Möbius bands. When I give talks for the undergraduate math club, this same theme guides my presentation of recreational topics from geometry and topology.

## UNDERGRADUATE RESEARCH

Another way my teaching overflows classroom boundaries is in undergraduate mentoring. In the past I’ve done reading projects with students, where we choose a topic and I guide their reading about that topic. During the summer of 2011 I had two students approach me independently because they had free time for the summer and they had heard I might be fun to work with. One student was interested in combinatorics related to lattice-point counting in high-dimensional polytopes. The other was interested in a power series calculation project related to my algebraic topology research. I decided to work with them, during a summer that was already quite full, because interacting with them was so energizing.

This is a phenomenon which can be observed inside and outside of the classroom: engaging students in creative, constructive ways is a source of energy and excitement that synergizes well with research activity. Because explicit computations are a persistent aspect of my research, there are more opportunities for undergraduates to become directly involved, and I look forward to further teaching and mentoring opportunities.

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<sup>1</sup>The “Fun Topics” links are available at [www.nilesjohnson.net/teaching.html](http://www.nilesjohnson.net/teaching.html).