# TEACHING STATEMENT

DAVID JENSEN

Learning is closely tied to communication. The mental processes required to articulate an idea – of organizing, prioritizing, and synthesizing information – are precisely the same processes through which we learn. Through communication, my students are constantly practicing the skills that I will later test, constantly receiving feedback on their progress, and constantly providing me with insight into their development. I purposefully design each assignment and classroom activity with communication as the primary goal.

This perspective has served me well as the instructor of many courses, of sizes ranging from 2 to 200, with students of various ages, interests, and maturity. Central to this philosophy, however, is that students must be immersed in a mathematical environment, with the opportunity to practice the language of mathematics as often as possible. Ideally, their mathematical experience does not begin and end at the classroom door. It is for this reason that I am dedicated to activities beyond the scope of the classroom. These include running two undergraduate reading courses, organizing and volunteering for three separate community outreach programs, serving as a mentor at Canada/USA Mathcamp, creating and organizing seminars for first-year graduate students, delivering a lecture series at a summer school in South Korea, organizing a conference in Europe for early-career mathematicians, and coordinating an undergraduate research group on tropical geometry.

## Small Classes

Setting up a class so that the student's role is to communicate is easiest when the class is small. My course on Mathematical Puzzles and Games, for example, had fewer than 30 students, as did Foundations of Arithmetic, a course for prospective elementary school teachers, and the Graduate Problem Seminar, a course designed to prepare students for the qualifying exam. Each of these classes made use of an Inquiry-Based format, in which students are at the board teaching their peers. The central tool in such a class is a collection of exercises that have been carefully designed to elicit fruitful discussion between the students. A student's job in one of these classes is two-fold. When they are in front of the class, their job is to lead a discussion on one of the exercises, and when they are seated, their job is to actively participate in the discussion.

Students can find this type of course intimidating at first, and there is usually an uncomfortable period early in the semester when students, hesitant to get up in front of the class, nervously direct their presentation at me rather than their fellow students. During this time it is important to reinforce my expectations by *requiring* the students to ask questions and summarize what they have heard. In time, as the students realize that I am not going to rephrase the presented ideas, their focus changes to summarizing and articulating these ideas themselves. For example, a typical class day for Mathematical Puzzles and Games might focus on an exercise like the following: "show that there are 2 students at Stony Brook who share the same birthday. What is the largest number $N$ for which you can be certain that there is a collection of $N$ students who share the same birthday?" Discussing this problem not only gives students practice using the basic concept – in this case, the Pigeonhole Principle – but also gives them practice with the fundamental aspects of mathematical inquiry, such as generalization, conjecture, counterexample, and clarity of language. Moreover, such discussions give the students the opportunity to refine and reflect upon these ideas in a way that simply solving the problem does not. As an added bonus, the students are always demonstrating the depth of their understanding in class, so I can always be assessing them.

## Large Classes

The goal of getting students to communicate can often be more difficult in larger classes. At Stony Brook, courses like Introductory Calculus or Mathematical Thinking can often have 150 to 200 students, making a

discussion-oriented class logistically impossible. With a bit of work, one can nevertheless set up a class with student communication as a central focus.

For example, while in-class time is devoted to lectures, it is still highly interactive. I place special emphasis on the nature of mathematical inquiry and the students' ability to participate in it. "This specific problem seems to involve a great deal of extraneous information that isn't necessary for solving it," I might say. "What should we, as mathematicians, do in a case like this?" After a few iterations, students learn the answer to this question, and over time these questions become less leading. In this way, students discover the natural progression of mathematical ideas and become responsible for generating such ideas themselves. This is reinforced by written work and exams that require students to engage in these meta-mathematical behaviors. In a recent course on Differential Equations and Linear Algebra, for example, I gave week-long take-home midterms that explicitly asked the students to generalize and make conjectures about ideas from class. Although these exams were, in my opinion, far more difficult than a traditional in-class test would have been, the students really enjoyed them and voted unanimously to take their final in this format as well.

In office hours, my goal is to get the students to talk to each other, rather than to me. When a student is struggling with a homework problem, I have him stand at the board and explain the ideas he has had so far. (A common response is that the student hasn't tried *anything* so far, which they quickly learn is unacceptable.) This explanation is usually enough for me to pinpoint the extent of a student's knowledge, allowing me to make a comment or ask a question that is likely to be helpful. When other students come in with the same question, I usually ask the original student to respond, facilitating a discussion that benefits both students at once.

I often encourage, and sometimes require, students to work together on assignments. This is reinforced by the types of exercises that I assign, which often ask students to provide an explanation in addition to computational work. When explaining this to students, I am not subtle about the point. "Your solutions should be written as though you are explaining them to a peer in this class who does not know how to do the problem. A good way to do this is to actually find a peer in this class to work with." This gives the students the opportunity to practice communicating mathematics outside of class and increases the amount of feedback they receive on their work.

## Outside the Classroom

As a corollary to this perspective of learning through communication, I believe that students grow the most when they are immersed in a mathematical environment. Ideally, students belong to a community that extends beyond the classroom, in which opportunities to practice mathematical communication are both abundant and authentic. I have had the good fortune to participate in this kind of community as an undergraduate at Williams College, a mentor at Canada/USA Mathcamp, and through participation in the University of Texas undergraduate Math Club. Because of this, I believe it is important for a department to offer a wide variety of mathematical activities for undergraduates, and over the years I have become involved in a large number of such activities myself.

As an example, I have served twice as a mentor for the Intellectual Entrepreneurship Pre-Graduate School Internship. This program is designed to encourage and prepare underrepresented minorities for graduate school while helping them to make an informed decision about their future. Our weekly meetings, usually over coffee, served as a forum for asking questions, exploring mathematical concepts, and offering my perspective on graduate school life. The communication-based approach allowed me to personally engage the students, to motivate and inspire them.

It is in this same spirit that I have coordinated the Saturday Morning Math Group and Austin Math Circle, two community outreach programs that bring in over 100 high school and middle school students each month from across the greater Austin area. Our mission is to foster a passion for mathematics in the students, to wonder and excite them, and to encourage an interest in mathematical opportunities as they enter the adult world. Each meeting features a guest speaker, and my primary goal is to kindle communication between this speaker and the audience. During my tenure as organizer of these programs, I have done this by encouraging our guest speakers to make their presentations more interactive and helping the speakers put together activities for the students. The lessons I learned while coordinating these programs have proven useful in my move from Austin to Stony Brook, where I volunteer as a speaker for the Brookhaven National Labs Gifted Math Program.

A recent, rewarding experience for me has been supervising an undergraduate research group on tropical geometry. Over the course of a semester, I met once per week with a group of three undergraduates and one high school student as they worked on using tropical techniques to prove a famous theorem in algebraic geometry. As in my classes, the students were initially hesitant to work together, preferring to channel their ideas through me for approval. I used the same techniques that I have developed in class to get the students to communicate with each other. Specifically, I instructed them to direct their ideas toward their peers in the group, required them to ask questions and summarize each other's ideas, and asked them to meet with each other outside of our weekly meetings to discuss ideas without me present. In the end, these students produced an elegant, 10-page paper that has recently been accepted for publication by an academic journal. This experience has left me with a number of ideas for future student research.

For me, teaching is one of life's most challenging and most rewarding endeavors. When I am truly engaged in conversation with a student, and I can see the spark generated by a new concept or beautiful idea, I feel honored to be a part of that moment. It is my hope to bring about many such moments, and continue to grow as an educator throughout the years to come.