

Teaching Statement

Joshua P. Bowman

Mathematics has a dual nature: it is a gathering of beautiful ideas as well as an array of tools for practical problems. It can be appreciated aesthetically for its own sake and also applied towards understanding how the world works. I have found that when both perspectives are emphasized in the classroom, students are better able to make crucial connections and maintain their interest. I seek to engage students in discussing and contemplating both aspects of mathematics so that they can appreciate the art and apply the analysis inherent in mathematical thought.

In order for students to develop a sense of mathematics as a living subject, it is important for the material in a course to connect with the work of professional mathematicians. Furthermore, mathematics surrounds us in our daily lives, and a well-trained student can find pleasure in picking out these occurrences. Thus I choose illustrations and exercises that are related to more advanced fields or to natural and cultural objects. For two semesters, I was the teaching assistant for an advanced multivariable calculus course, whose students were mainly freshman math majors. The course included introductions to topology, linear algebra, and submanifolds of Euclidean space. I held weekly enrichment sessions and posed exercises involving concepts from areas related to my research, specifically complex analysis and differentiable manifolds. In an ordinary calculus class, when hyperbolic functions are introduced, we compute the length along the side of the St. Louis “Gateway Arch”, which has the shape of a catenary (hyperbolic cosine). As an instructor and consultant for the Cornell math department, I tested and edited weekly workshop problems designed for an engineering course on integral calculus.

My philosophy is that teaching should involve both lecture and guided discovery. I generally begin a class by reminding the students of something they have seen in the past, and then develop the new topic based on their previous knowledge. Because it is essential that the students grapple with each concept on their own, I almost always have a period during class for discussion or practice. I try to close each class period by indicating how the material will progress.

I am also committed to educational issues related to accessibility and empowerment. From fall 2000 through the summer of 2002, I taught secondary mathematics in Guinea, West Africa, as a Peace Corps Volunteer. During that time, I taught algebra and geometry to over 250 students. I started a math and science club, the *Club Scientifique de Kérouané*, which initially provided a venue for encountering non-traditional topics: we explored subjects like cryptography and fluid properties of the atmosphere. Through collaboration with other teachers at my school, the club became a permanent feature of the school and a means of supporting regular review sessions for students in science and mathematics. I learned about many of the real obstacles to universal primary education, and became more firmly convinced of its importance.

In the summer of 2008, I taught a pre-calculus course for Cornell’s Pre-Freshman Summer Program (PSP), where I covered all of the usual prerequisite topics for calculus as well as a brief introduction to tangents and derivatives in the special cases of circles and parabolas. The PSP is a six-week program designed to help talented students, primarily minorities, transition from high school to the university. My purpose was twofold: to prepare those students who wished to continue taking calculus and to provide a basis for informed scientific discussion among those

who did not. Students' feedback during the course indicated that they found the material both challenging and beneficial. Several of them did continue into college-level calculus, even though the students in this particular class would not normally be expected to do so.

Mathematical learning is usually inductive, and so it is important to build intuition through interesting, concrete examples. For example, when teaching a second course in calculus, I begin by reviewing the Fundamental Theorem of Calculus with an exercise that asks the students to find the area of a circle knowing the formula for the circumference of a circle. By applying integrals to study how areas and lengths can relate (in a way different from the usual "area under a curve" application), they begin to make sense of how analysis pulls together small bits of information into a whole. In this particular case, they learn that "the derivative of the area of a circle with respect to the radius is the circumference" in more than a purely formal way. This example proves fruitful later in the course as more and more techniques focus on appropriate ways of breaking up a problem into small pieces and then reassembling them.

Effective teaching requires a balance of several skills: anticipating students' questions, responding to the questions that are actually asked, and challenging the students to ask new questions. In all of my teaching experiences, I have found that the keys to communication are accepting that different people understand the ideas in different ways and supporting them in their growth. As a result, both preparation and flexibility are necessary in the classroom. My best classes are always those for which I have several examples worked out (in sufficient detail that I know where the sticking points are), with a thread of logic between them.

By teaching, I experience again and again a renewal of my own interest and excitement about mathematics. My time spent teaching in Peace Corps led me to the decision to pursue graduate studies. Each class I teach provides an opportunity to consider afresh ideas and examples that have inspired minds throughout the ages. The greatness of the classroom is that these experiences of "discovery" can be shared and enhanced by the joint efforts of teacher and students. I look forward as part of my future career to improving the standing and effectiveness of mathematics education in my college or university department.