TEACHING STATEMENT
LAURA A. MILLER

My primary interest in mathematical teaching is multidisciplinary education. This includes teaching mathematical and experimental biology to mathematicians and mathematics to scientists and students from nontraditional backgrounds. These interests are reflected by my teaching experience in both the biological and mathematical sciences. For example, I served as a teaching assistant for an introductory biology sequence at the University of Chicago that was developed specifically for mathematics and physics majors. At New York University, I served as a teaching assistant for a mathematical biology course designed for math undergraduates and biology graduate students. I also taught a graduate level course on probability and its applications to computer science at the City University of New York. In addition to courses that relate mathematics to the sciences, I am also interested in teaching mathematics to students from the humanities or social sciences who might have difficulty with the subject.

TEACHING EXPERIENCE IN BIOLOGY

My first teaching experience was in the Department of Organismal Biology and Anatomy at the University of Chicago. I served as a teaching assistant and laboratory instructor for a three quarter introductory biology sequence designed for mathematics and physics majors. This sequence was a survey of mathematical applications to systematics, developmental biology, biomechanics, neurobiology, cell biology, and ecology. Throughout the year, I helped Professor Philip Ulinski develop the laboratory component of the course which was meant to tie mathematical theory to experimental biology. I found this course to be particularly interesting because it covered not only the basics of traditional areas of mathematical biology such as neurobiology and ecology but also less standard areas such as systematics and biomechanics. For instance, I developed my own laboratory discussion on mathematical modeling in plant biomechanics, an area in which little mathematical work has been done.

At Duke University, I continued to teach courses in the Zoology Department that emphasized mathematical modeling in biology. For example, I served as a laboratory instructor for a course on animal physiology for several semesters. The laboratory section focused on experiments in neurobiology and muscle mechanics. However, the foundation of the experimental exercises was based on a mathematical framework. For example, some of the laboratory exercises involved measuring action potentials along the frog sciatic nerve and comparing the results to predictions based on the Hodgkin-Huxley equations. Much of my time as a laboratory instructor was spent reviewing basic mathematics and helping students to develop an understanding of mathematical modeling and how it can be used to enhance biological understanding. I also served as a teaching assistant for a graduate course on plant anatomy and biomechanics. The laboratory component of this course was based on a mixture of mathematical modeling and experimental exercises. One laboratory exercise I developed considered wind forces on plants and vortex shedding behind plant stems. Students performed wind tunnel experiments and measured drag forces and vortex shedding frequencies.

TEACHING EXPERIENCE IN MATHEMATICS

In addition to my teaching experience in the biological sciences, I have taught a wide variety of mathematics courses at the Courant Institute of Mathematical Sciences. At the lower level, I have served as a teaching assistant or instructor for courses such as Mathematical Thinking, Quantitative Reasoning, and Precalculus. At the advanced level, I have served as a teaching assistant for Mathematical Statistics and Mathematical Analysis. I have also taught several multidisciplinary courses such as Mathematics in Medicine and Biology and Decision Analysis.
This diverse range of experience has prepared me to teach a number of possible courses in mathematics.

I have thoroughly enjoyed teaching lower level mathematics to non-majors while at New York University. Two courses I taught, *Mathematical Thinking* and *Quantitative Reasoning*, were designed to fulfill the mathematics core requirement for humanities majors. One of the biggest challenges I faced while teaching these courses was to captivate the interest of the students in mathematics. I found that combining the curriculum with activities that have real world applications substantially increased the students’ interest. One of the activities I designed for *Mathematical Thinking* was to have the class make Excel spreadsheets that calculated compound interests for various rates and lengths of time using the compound interest equation. I also had the class do individual projects in which they developed budget spreadsheets that included interest gained from savings and lost to debt. In my opinion, it is also important to help the students develop an appreciation for pure mathematics. Part of my course also focused on how to write and understand complete mathematical proofs.

I also have considerable experience teaching multidisciplinary courses in mathematics. For example, I served as a teaching assistant for several semesters for a course on mathematical biology. This course was designed for advanced undergraduate students in mathematics and graduate students in biology. One of the biggest challenges of this course was to teach the subject to students from drastically different backgrounds. In order to help each student get the most from the class, I reviewed the relevant basic biology and mathematics for each section of the course and then combined the two into mathematical models. I found it particularly useful to provide students with supplementary material in mathematics and biology so that they could easily review any problem areas. I spent a good deal of time helping individual students during office hours and appointments since each had particular areas of concern. I found that it was also beneficial to distribute detailed solution sets to each homework assignment so that the students could pinpoint any difficulties they were having with mathematics or biology and bring it to my attention.

**FUTURE TEACHING**

I am particularly interested in teaching mathematics courses for non-majors and interdisciplinary courses for scientists and mathematicians. I think my previous experiences would be quite useful in the teaching of the lower level courses offered by the department. In light of my extensive coursework in both the sciences and applied mathematics, I feel I am particularly qualified to teach calculus courses taken by scientists and engineers. In particular, I believe that I am especially qualified to relate the mathematics taught in these courses to applications in the students’ fields of study. I would also be very interested in designing an upper level undergraduate / graduate sequence targeted for biologists which surveys mathematical techniques in biology (i.e. basic linear algebra, numerical analysis, ODE and PDE).

In addition to undergraduate courses, there are also several graduate level courses that I would really enjoy teaching. For instance, I would be particularly qualified to teach courses in fluid dynamics, numerical analysis, and mathematical biology as I have considerable experience in these fields from my coursework at NYU and my doctoral research. If given the opportunity to design my own course, there are several upper level undergraduate or graduate courses that I would really enjoy teaching. For example, I would be happy to teach a course on biofluids. This course would cover current research topics in swimming, flying, circulation, and seed dispersal. I would also be quite interested in teaching a course that surveys various areas of mathematical biodynamics. Such a course would cover mathematical ecology, biomechanics, pattern formation, neurobiology, mathematical cell biology, and control theory in biological systems. I have outlined a syllabus for such a course below.
Outline for Mathematical Biodynamics

I. Mathematics of Ecology and Evolution
   A. Predator Prey Models
      1. Lotka-Volterra Equations
   B. Adaptive Landscapes
      1. Random Walks over Adaptive Landscapes
      2. Evolutionary Algorithms

II. Biomechanics
   A. Biofluid Dynamics
      1. Navier-Stokes Equations
         a. Streamlines
         b. Conformal Mapping
      2. Insect Flight
         a. Kutta-Joukowski Lift Theorem
         b. Weis-Fogh Mechanism
   B. Biomaterials and Dynamics
      1. Beam Equation
         a. Natural Frequencies
         b. Mode Shapes

III. Pattern Formation
   A. Reaction-Diffusion Equations
   B. Pattern Formation during Development
      1. Patterning of Insect Wings
      2. Evolution of Pattern Formation Mechanisms
   C. Geometric Patterns in Bacterial Colonies

IV. Neurobiology
   A. Action Potentials
      1. Hodgkin-Huxley Equations
         a. Derivation
         b. Properties
   B. Population Density Approaches
   C. Integrate-and-Fire Neurons

V. Molecular Biology
   A. Biological Clocks
      1. Coupled Oscillators
      2. Effect of Noise
   B. Control Theory in Molecular Biology
      1. Positive and Negative Feedback Loops
   C. Enzyme Kinetics