TEACHING STATEMENT

JOHANNA N.Y. FRANKLIN

I have found that for many mathematics students, it is very easy to miss the forest for the trees. They may get caught in the trap of memorizing formulas without understanding the contexts in which it is appropriate to use them, or they may read proofs line by line without understanding the ideas behind them. I believe that as an instructor, it is my job to give them a motivation and context for the information they are learning as well as to explain and reinforce the details. When I teach, I try to explain the course material as I would tell a story to help the students understand how the concepts we're discussing relate to each other and view the course as a unified whole. I believe that this makes it easier for the students not only to remember the formulas and theorems I present but to place them in a broader context.

When I teach lower-division courses, I focus on the plot and the setting: I explain why they will need to know the material outside of my classroom and introduce them to the vocabulary and key ideas of the subject. To tell this story most effectively, I need to know what the students are expecting and what they are interested in. Distributing surveys on the first day of class helps me choose my approach to the course material to connect best with that particular group of students. For instance, when teaching calculus for humanities students, it is useful to know whether most of the students are afraid of math or whether they see the course as an easy A, and knowing my students' majors helps me choose examples to make my course more relevant to them. If I have several future biologists in a differential equations class, I can talk about modeling population growth with a logistic growth function; if I have more sociologists, the same function can be used to model the spread of a rumor. At Dartmouth, I began to ask if my class was required for their prospective majors and, if so, why they thought that was. I hope to make them think about how the course can benefit them in the future and not just that it will satisfy a requirement.

When I lecture, I emphasize the terminology the students will have to know to improve their understanding of the underlying concepts. In a calculus course, this may be the difference between instantaneous and average velocity; in a linear algebra course, this may be the difference between a spanning set and a basis; in a probability course, this may be the difference between independent and disjoint events. When I do examples, I emphasize the importance of checking their answers. For instance, if I am doing an optimization problem, I always check that the final answer satisfies the given constraints. This gives the students a set of tools to evaluate their own work as well as the skills to do it in the first place.

When I teach a transitions course, my story is designed to introduce the students to the idea that there is more to the material than the formulas and the “literal” content and to teach them how to find an underlying meaning in the mathematics by themselves. While the students tend to have an appreciation for math, they may not intend to study theoretical mathematics: at Waterloo, the transitions course was required for many future computer scientists, while at UConn, I teach mostly pure math majors. I like to begin with basic number theory so they can learn to write proofs in a setting they understand intuitively and then progress to more complicated concepts like
the completeness of $\mathbb{R}$. One of the main goals I have for my transitions students is for them to learn to work with their peers to understand new concepts, so group work is an integral part of this kind of class. For instance, I might give them a definition of something they have never seen before like a metric space and ask them to work with their classmates to determine whether certain pairs $(X, d)$ are metric spaces. Since the goal of this course is to prepare them for future math courses, I feel that I need to not only teach them how to develop and write proofs but also how to approach and understand a new mathematical concept.

When I teach an upper-division course, however, my emphasis shifts entirely to interpreting the story. I am able to assume that the students are interested in the course material, and I am able to assume a certain amount of mathematical maturity, including the ability to understand how one step follows from another in a proof. However, I cannot assume that they will understand the general theme of a proof on their own. For instance, the proof that the cardinality of the set of functions from $\mathbb{N}$ to $\{0, 1, 2\}$ is the same as the cardinality of the set of functions from $\mathbb{N}$ to $\{0, 1\}$ requires the construction of an injection from the former to the latter. If the injection is simply presented without an explanation, it is possible for a student to follow the proof but not understand why the chosen injection works except on a line-by-line level. Therefore, while I go through the proofs rigorously, I try to make sure that they understand the overarching ideas as well.

Finally, when I direct an independent study, I have two main goals for the student: learning the material and developing professional and research skills. I try to maintain a structure for the course while requiring the student to learn independently. When I supervised an independent study in Singapore, my student and I agreed on the readings and a timeline before the semester began. He was responsible for obtaining all the readings on his own, including a journal article available through the university library’s e-resources. At the end of the semester, he presented his final project, which included some original results, not only as a paper but also as a talk in the departmental logic seminar.

I find that I am at my best in the classroom, both in terms of delivering the material and building a rapport with my students, when I spend time with my students outside the classroom. A casual remark in office hours can tell me that I should take the time to go over the unit circle in class, or discussions about the course material can lead to independent research projects. I encourage students to come to my office hours early in the semester even if they don’t have anything in particular to ask about so I can learn their names more easily and learn more about them. I chat with students after class, and they often come to me for advice on additional math courses to take even though I have never officially advised a student.

In every class, I make sure I get feedback from all of my students over the course of the semester. Around the midpoint of the semester, I stop class a few minutes early one day and ask my students to tell me what they think both they and I are doing well and what we could each improve. Generally, their responses indicate that the course is going well, but I often receive useful suggestions. For instance, when I taught combinatorics, the problem sets in the textbook I used each had about 100 problems. Several students suggested that I give them lists of the problems that would be particularly helpful for them to do, and I began making these lists and posting them to the class’s online forum immediately.

**Teaching in the US and abroad.** Teaching abroad presented me with a new set of challenges. While my Singaporean students were very much like their American counterparts in many ways, there were some key areas in which I had to adapt to be an effective teacher.
The main difference I found was that my students at Berkeley were more willing to speak up in class than my students at NUS, so I had to develop new strategies to encourage classroom participation. For instance, when a question was met with silence, I told the students to break up into groups of three and discuss the problem for five minutes. During that time, I circulated among the groups, and afterwards, I chose a group at random and asked for their thoughts. The shyer students were more comfortable asking for clarification when everyone was engaged in group work, and all of the students were more confident presenting the group’s ideas than their own.

Teaching in Singapore not only taught me new techniques for encouraging student participation but also gave me more experience with students from diverse linguistic and cultural backgrounds. This helped me at the University of Waterloo when my class had a very large number of international and ESL students.

Technology and the classroom. I have found a judicious use of technology to be helpful when I teach. I have used WeBWorK and WebAssign, which generate individual problem sets for each student and let them submit their computational calculus homework online, and as a TA for an introductory logic class, I used a theorem-proving program that allowed the students to build counterexample “worlds” and helped them understand concepts like universal generalization. I try to use computer simulations in class, too. Showing the students simulations of experiments such as a Galton board and the Coupon Collector Problem are very useful in my probability classes, and the use of Maple to help the students visualize solids and parametric surfaces is invaluable when I teach multivariable calculus. This helps me create an environment where I can guide their explorations in mathematics instead of simply lecturing: “What happens if we change the bounds on φ?” “How often is the winner in the lead in a penny-matching game?”

Each semester, I build a website and, if it seems appropriate, set up an online forum for each of my courses. I typically do not post on the forum myself unless a question is directly addressed to me or all of the students are on the wrong track after 24 hours. If I am teaching a coordinated course, I keep my own website for my students with additional examples, links, and practical information about the course. I hope that by compiling these notes on a website instead of sending them out in e-mails, they will be easier for the students to refer back to.

Although I prefer to write on the board, I have lectured with slides on a tablet. When I did, I made sure to post my slides online far enough in advance for the students to print them out. Instead of putting full proofs or computations on my slides in advance, I only included the statement of the original theorem or problem so no one had to take the time to write down the problem, though I still did the work in real time.

I have developed these teaching techniques through my experience with a wide range of courses. The first-year calculus students I have taught at a liberal-arts school are different from the first-year math majors I have taught at a technical school, and they, in turn, are different from my students in upper-division courses at large public universities. I am good at putting myself in my students’ shoes, recognizing what they need and want from my class, and determining what will help them learn most effectively. In working with your students, I would continue to use the practices I’ve found to work best and hone these practices to meet their particular needs.