Teaching Philosophy Statement

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Is Mathematics a Science or Art?

This question perfectly sums up the multifaceted nature of mathematics. On the one side it is a very precise science with all its formulas and computations. On the other side it acts like art, where the connections and patterns are clear to us at an intuitive level, but may never be put in scientific language. For me and many other mathematicians, the beauty of mathematics lies in finding the balance between scientific precision and intuitive understanding. Unfortunately, however, mathematics is sometimes seen as a technical subject foreign to us, that can only be mastered by certain chosen individuals, completely ignoring the intuitive side that is innate to us. Thus in our society reading is seen as an integral part of what makes us human, whereas mastery of algebra is somehow an extraordinary skill!

It is my goal to help my students see their inherent mathemetical abilities by focusing on the intuitive aspects of mathematics. From my personal experience many students think that learning math means memorizing meaningless formulas, random facts and irrelevant theorems which came out of nowhere. My main motivation for teaching mathematics is to convey the part that is missing to my students, to show them what lurks behind these formulas and how they are connected. My hope is that this will lead to a higher appreciation of and enthusiasm for mathematics. Concretely, I try to achieve this by

1. Showing them valuable proofs and concepts,
2. Humanizing the classroom experience,
3. Tailoring the material to the classes needs.

Showing them valuable proofs and concepts: First, I believe that the best way to learn new mathematical concepts is by understanding its connection to other concepts as well as how it was proven. However, presenting an abstract proof might not always be a good idea, as is captured in the expression "*You can only understand a proof if you are able to prove it yourself.*" Therefore, I try to approach every material as if it is a town that students have to traverse. Every mathematical concept is its own town square and the proofs and examples that relate them to each other are streets. I design every single worksheet with this mental image in mind.

I start the semester by handing out "course teasers" which give a general overview of the topics covered in class and serve as overview of the country. For each specific course material I start at the city gate, often called definitions, and provide city signs that guide the students through the concepts as if they are taking a stroll through the town. I try to connect every new subject to previously taught material, giving them high ways to previous towns. Whenever a new concept is extra difficult, I give students small detailed steps to help them understand it, the same way I would give a traveller detailed steps on a very complicated route. The beauty of this approach lies in the fact that students have to travel the route themselves, as I do not carry them to their destination. Using this approach I help students teach themselves concepts ranging from Taylor series to parametrizations of tangent planes. Finally, before every exam I hand out review sheets to my students reminding of the the cities we have seen together for the past month.

For other important concepts, I choose important examples which capture the essential steps of the proof. For example, when I want students to compute the derivative of an inverse function I remind them of the

fact that it is simply the reflection of the original function by having them draw a couple inverse functions. Visualizing the scenario makes it very clear what the derivative of the inverse function is and how we can find it. In another situation I use an example of a hotel with infinite rooms, commonly known as the "Hilbert Hotel" to make students visualize the concept of indeterminate limits. Using this mental image, I can easily illustrate to my students why we cannot simply subtract infinity from infinity, as I can empty an infinite number of rooms in the hotel, but still have an infinite number of guests remain!

Humanizing the classroom experience. College students impressions of mathematics is inevitably tied to their experience of their instructor and so humanizing this experience and showing passion for the topics can go a long way in showing how math is more than formulas. Over the years I was fortunate enough to work with the *Merit program* [1] in my department, which is a program designed to help traditionally underrepresented students better integrate into the campus and academic community. The focus of this program is on small classes with high exposure to the instructor paired with a strong active learning component. This environment was perfectly suited to achieve my stated goal. For example, I always go to class 15 min early and encourage students to come to office hour in order to have the opportunity to chat with my students, ask them if anything exciting happened and how they feel about our class. I also don't lose sight of any of my students. When one of them misses class or falls behind, I contact them to make sure everything is OK and, if need be, even meet them and try help them on a more individual level. More generally, I use various online tools to make myself and the class material readily available to my students. I always have website for my section where students can find all the previous worksheets and other material. Moreover, I always encourage students to email me if they have any questions and try to respond as promptly as possible. Using all these tools I am effectively able to connect with my students on a personal level and play the role of a guide rather than a instructor.

Tailoring the material to the classes needs: Despite some commonalities every class has its own unique culture. Thus I try my best to tailor my class their specific needs. For example I hand out a questionnaire on my first day of classes in order to gain some understanding of each students background and their previous experience with math and math teachers. Throughout the semester I try to get feedback whenever I chat with them. For example, after talking to several students on why they missed a homework I realized that students were not familiar with factorial (an important prerequisite) and so I went over it later in class. In addition to that I also use feedback forms to garner opinions that students might not be comfortable sharing. Using this style of thinking I don't just use homework and quizzes to give feedback to my students, but also as a crucial source to gather how much students have learned in class and whether I have to adjust my approach or review a subject.

I gained the skills and techniques I use today by employing experiences I gathered in my classrooms. However, I also used opportunities outside the classroom to advance my teaching skills. I have been a TA mentor on several occasions, where I had to observe TAs several times and give them constructive feedback. Besides sharing my own experiences with my mentees I have used those opportunities to grow. Over the years I have incorporated various techniques into my own regular teaching practices. In addition to that, I was also a mentor of an undergraduate research team as part of the *IGL* [2] where I had to explain intricate topological concepts to freshmen students. The situation forced me to explain those concepts by completely focusing on examples and intuition as I could not use any advanced mathematical notation. I have been using the skills I learned there every time I want to show my students valuable proofs and concepts as outlined before. Moreover, the *CITL* [3] offers several teaching workshops and certificates that I have used to advance my teaching practices. I am hoping on using more opportunities to further advance my teaching practices.

[1] Merit Program for Emerging Scholars http://merit.illinois.edu/
[2] Illinois Geometry Lab https://math.illinois.edu/research/igl
[3] Center for Innovation & Learning http://citl.illinois.edu/