

Teaching Statement  
Bhargav Karamched  
Department of Mathematics  
University of Houston  
Winner of Outstanding Graduate Student Award, '15-'16

Mathematics is the language of the sciences. Indeed, one could argue that physics and chemistry have played the central role in modern science over the past 400 years, and that mathematics has been the language used to elucidate their respective narratives. Furthermore, we have reached a point in time where biology and mathematical modeling have begun their amalgamation. Hence, mathematics and fundamental science are a singular indissoluble entity. This idea has formed the basis for my teaching methodology.

The issue with how mathematics is taught today stems from the lack of context. That is, mathematics is presented as a set of very specific problems which require certain methods to solve. For example, as an instructor for a standard ordinary differential equations course, I introduced the logistic growth model for population dynamics as a better model than the law of natural growth, but I did so without providing insight into the mechanics of the derivation of the equation or its history. In the students' eyes, the logistic equation was simply another equation that had to be solved using separation of variables. Of course, this method of teaching achieves particular goals; namely, students will have a bag of handy methods they can rely on to solve problems given to them, say, on an exam. On the other hand, it fails to address a common problem that math instructors have: students, in general, do not have the ability to formulate application problems (or word problems) in the language of mathematics and draw conclusions from their work. This, again, rises from the fact that mathematics is presented as a separate entity from the sciences rather than as their representation.

If instead mathematics were presented as a means for providing a conceptual framework for scientific phenomena, students' outlook on the subject would be entirely different. This type of teaching arises most naturally in partial differential equations, whether we are deriving the heat equation from conservation of thermal energy or the wave equation from Newton's laws. The fundamental scientific principles provide students a concrete framework to visualize the results of the mathematical equations that are derived from these foundations. This in turn motivates students to learn the methods to solve equations as a way to draw tangible conclusions from their mathematical work. Indeed, several students approached me when I was teaching partial differential equations and remarked on how much they enjoyed solving the problems that they could relate to the real world. I strive to introduce any mathematical theory or equation as motivated by some scientific problem, and indeed I describe how the mathematics can be derived from scientific principles, before delving into methodologies to solve the mathematical problems. In addition to motivating students to learn the methods, this way of teaching also prepares students to tackle application problems.

Another issue students face in math classes is that they are convinced that mathematics has to be memorized and that there is no room for creativity in solving mathematical problems. As an applied mathematician, I feel that the most challenging

and most rewarding part of modeling is the construction of equations which adequately capture the dynamics of the phenomenon being modeled. I find this skill to be highly undervalued in the mathematical community, as, again, solving mathematical equations that are already present is emphasized. While this certainly is an important part of mathematics, it is given too much preference in the classroom; disregarding construction of mathematical models in classes removes the creative element. I find that motivating mathematics from science and deriving equations as often as possible leads to a great interest in the material from the students. It facilitates an active classroom as it encourages questions and an exchange of ideas between the students and me.

One may argue that in relying so much on scientific principles to motivate mathematics, I may be catering to students who are inclined to studying engineering, theoretical science, or applied math and ignoring those who are interested in pure mathematics. I disagree. Encouraging creativity and keeping an active classroom promotes interest not only in what mathematics can tell us about the world, but in the mathematics itself. In fact, a mechanical engineering student who took my calculus II course switched his major to pure mathematics upon completing my course, and today is a graduate student of pure mathematics in my department.

Finally, my philosophy of teaching mathematics allows teachers to keep their students up-to-date on mathematical research by allowing students to be exposed to more modern applications as opposed to classical ones. For example, in my partial differential equations class I derived the classical heat equation and discussed problems related to heat flow. But what is more, I was able to speak to its interpretation as the diffusion equation and hence bring forth ideas stemming from biology, for example. In discussing bifurcations with my ordinary differential equations class, I was able to provide the dynamics of the cell cycle as an example of a bistable switch. As researchers, one of our duties is to create interest in the research in our fields so as to promote its progression and prevent it from stalling. My style of teaching facilitates this process.

Hence, I believe mathematics should be presented to students as the language of the sciences as opposed to as an entirely separate entity. My efforts in this regard led to my winning the 2015-2016 Outstanding Graduate Student Award and to a high volume of favorable reviews from my students. This teaching philosophy has worked for me. I hope to keep developing it and grow as a mathematics instructor.