Teaching Statement

I believe that teaching is essential to the field of astronomy since the goal of teaching is not only to give students tools for productively contributing to the field, but to help students develop a scientific way of thinking. Achieving these goals are clearly important to majors in the field. However, non-science majors may be taking introductory astronomy to fulfill their few science distribution requirements at a university, and it is important to give these students a chance to look at the universe from a scientific point of view. Concepts taught in a science like astronomy, such as statistical significance, back-of-the envelope approximations, mathematical reasoning, and laws of physics, have many applications outside academics and give students new approaches to solving problems. Engaging students in non-major courses may be one of the best ways to combat scientific illiteracy in American society. Advanced astronomy courses will also provide skills with many applications in different areas, such as modern statistical methods, a better understanding of physics, and experience with scientific writing.

In my experience teaching introductory astronomy lab at Penn State, many of the students come to the course without having any idea how to approach the field. However, by the end of the semester a lot of students are properly using the scientific concepts described above to discuss their lab results in the lab write-up. Long after taking this course, many of these students may not remember concepts from this course, like the evolution of stars on the Hertzsprung-Russell diagram, but, hopefully, they will continue to consider science a valid and useful way to approach the world.

I believe that a mixture of instruction and active learning is the best strategy for me to teach astronomy. Lecture and readings from textbooks or papers are often the most efficient ways to teach the detailed and precise facts that are essential to a scientific field, particularly for teaching mathematically-intensive derivations. However, active learning techniques, such as projects or classroom discussions, are often more effective at making students learn abstract concepts or improve their astronomical thinking - which is often the most important component of a course. Active learning techniques are also effective at stimulating higher order thinking skills, such as evaluation (developed by student led class discussion of recent astronomy papers), and creation (developed by student projects and presentations on topics chosen by students.)

I think that the materials and methods used in activities should be materials and methods that are useful outside the classroom. Thus, in my class I will try to include student presentations, papers written in LaTeX, and computer programming. When possible I give homework assignments that use real astronomical data sets. In courses that I have taken, many of the more memorable projects have addressed scientific problems as they are encountered by a researcher, starting with basic data reduction and proceeding through an analysis that uses the concepts being taught in the course – so I would try to include similar assignments in courses I teach.

At the Winter School for Astroinformatics at La Serena (2017), I joined instructors from both the United States and Chile to teach advanced undergraduate students and graduate students in a program to provide a better statistical foundation to young astronomers. In the program, I taught Gaussian mixture models, as well as providing an introduction to the R programming language for students, and mentorship during the student-led final projects. For the lesson on mixture models I provided a mathematically formal view of the topic because I believed that it was one of the goals

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of the school to introduce statistical concepts to astronomers as they would be introduced in a statistics class. However, I interspersed the lecture with coding exercise that the students had to work though. This made sure that the students would need to follow along well enough to run the R code, and if they did not, would need to work with their peers to get the examples to work. In particular, the Expectation Maximization (EM) algorithm is often difficult for students to understand the first time it is presented. Because the EM algorithm was one of my main objectives, I chose to dedicate a significant portion of the class time to have students work through a example of this method in R, using simple easy-to-understand commands rather than black-box routines.

I made the mixture-model lecture notes available on the course website, including the presentation with mathematically formal descriptions, the R exercises from class, and some examples of further advance applications written in R. Given that the students had a large amount of statistics to absorb during the ten-day school, it is unrealistic to expect them to remember every concept from every lecture. However, with access to lecture notes, they have resources to look back at concepts they are interested in. The example R code of advanced applications of mixture models was designed to be modifiable for the student's own purposes, and it can give any interested students an idea of where to go if they want to explore the topic in more depth. A day after the course, one of the students asked me for help modifying one of the examples in R (Gaussian mixture models for surface-density estimation) so that she could use it for her application.

In order to teach effectively, it is important to learn about methods in teaching, including new methods. I took the Course in College Teaching at Penn State University, which I hope has helped me develop my teaching philosophy and given me strategies to implement it more effectively in a classroom.