I once had a student ask me if an astronaut would fall off the moon if he was standing on the bottom of it. I was dumbfounded but did my best to explain the concept of gravity to her. This question was asked by a woman who had nearly completed four years of college at a reputable institution. Although the question was startling, I had to ask myself, did it matter that after all her education she did not understand gravity? The answer seems self-evident. Of course it matters! But, why? The student went on to be a middle school English teacher where the subject of gravity likely never comes up. I have spent a great deal of time pondering why science concepts, seemingly irrelevant, actually matter to the general public, and the result has shaped my teaching philosophy. Ultimately, the goal of education is to create productive members of society. Students need to be well-informed and possess honed critical thinking skills. A solid science foundation gives students the tools necessary to be discriminating citizens.

Education Focus
My primary objective as an instructor is to ensure that my students understand the scientific process. It is important to teach students how to recognize the difference between rigorous science and pseudo-science, especially when dubious information is readily available to every internet user. I find that students are eager to learn about science concepts and think critically when they find the topic stimulating. As such, I center my teaching around giving students a general appreciation for the larger Universe beyond Earth’s horizon. Although I do go into detail about astrophysical processes (such as nuclear fusion in the core of the Sun), I always make sure that students keep the big picture in focus (what will ultimately happen to our Sun, and what does this mean for the Earth?). Ensuring students have a broad view of astronomy is a particularly relevant goal for teaching at a liberal arts college since the purpose of a liberal arts education is to obtain a general knowledge of the world. After all, a literature major is not going to need to understand the difference between the radiative and convective zones in the Sun. But he or she does need to understand ideas like how different the Earth is from the other planets and how large the Solar System is. These concepts make students aware of our own frailty, ideally provoking them to be more conscientious about how humans impact the Earth. At the same time, a survey of astronomy and astronomical techniques enables students to better evaluate some of the science claims they will encounter outside the classroom.

Teaching Style
I have taught students ranging from elementary to college-age over the course of several years, and I have tried many techniques with varying success. I have cultivated two methods for teaching effectively: 1) make science accessible; 2) cater to different learning styles.

Making Science Accessible
I like to ask students when I am lecturing how astronomers actually gain knowledge. For example, how do we know what elements make up a star? This question often baffles students and forces them to think about how modern science is performed. I use class assignments to demonstrate scientific techniques. During a lesson on the stellar spectral classification scheme, I hand out a packet of stellar spectra, along with a guide showing a typical spectrum from each type of star (O, B, A, etc.). I then have the students assign a classification to each spectrum. We discuss results, and students are surprised when I tell them there is no answer key. I am not
giving them a grade based on getting it “right” but rather on their logic and justifying their answers. I conclude the lesson by explaining this is how science is done. Scientists debate and come to a general consensus over time. Students are perhaps frustrated to not “know the answer”, but they are also eager to defend their results and feel pride in their reasoning skills.

I further stimulate interest in astronomy by showing students that they can participate in research now. I am particularly fond of GalaxyZoo and have used it with high school and middle school students. After a lecture on the Hubble sequence, I show students the website and have them classify galaxies and answer questions about the process. Students are enthusiastic to learn that what they are doing will actually be used by scientists to study galaxy evolution.

I find models very helpful in making difficult concepts understandable. I frequently bring in models that the students can touch, like a celestial sphere. In one class assignment, I had the students read about the geography of the terrestrial planets. I handed out the appropriate globe, and the students had to demonstrate where certain geological features were located. While teaching at UMass, I included field trips to the planetarium at Amherst College and the Sun Wheel. The planetarium brought to life ideas like the zodiac, the ecliptic plane, and circumpolar stars. The Sun Wheel added a dimension to my lesson on ancient astronomy and segued into a discussion on calendars, sidereal versus solar time, and the movement of the sun on the horizon.

Catering to Different Learning Styles

Some students learn well listening to lectures, while others learn by doing. I can reach the most students if I use a variety of teaching methods in my classroom, an idea that is best illustrated by discussing a typical lesson plan. I start each class with a student-led review of what we talked about the day before. Then, I have a warm-up activity designed to complement the lecture. For example, when discussing planets, the classroom had posters describing the planets, so I handed out a questionnaire requiring students to read each poster to fill in the answers.

The body of the lesson is typically a lecture, but I keep it interesting by showing short videos or demonstrations, or by having students deliver part of the information. During a lesson on cosmology, I gave students articles detailing discoveries in the field and asked them to write the key discovery on a notecard. As the lecture progressed, I had students present each discovery at the appropriate slide and then place their notecard on a timeline on the whiteboard. This not only livened the lecture, but it also gave students a visual to understand how the field developed.

Because students learn differently, I feel that grades are assigned most fairly when multiple methods of assessment are taken into account. In my classroom, tests comprise part of a final grade, but I also include homework and participation in class discussions. I assign the most weight to a research project, since I feel that this shows sustained effort and interest. When I taught high school students, I assigned each student an intriguing topic (Why is there methane gas on Mars? Could an asteroid collide with the Earth?) and asked them to research it and give us a 15 minute presentation. We worked on their presentation skills, including how to design an effective slide and how to pace their talk. In the class evaluations, most students commented that the research project was their favorite part of the class.

Part of being a scientist and having a specialized knowledge of the world is the responsibility to convey such knowledge to others. If people believe that the moon does not possess gravity, then those of us who know better have failed them. I am committed to educating
students and the general public, and I have the experience necessary to design an effective course. Astronomy is an ideal vehicle for teaching science concepts and techniques because it invokes awe and wonder in so many. Students enjoy learning about the mysteries of the Universe, while we teachers are able to enhance critical thinking skills that will serve students long after they have left the classroom.