The following is a contribution to the JREF's ongoing blog series on skepticism and education. If you are an educator and would like to contribute to this series, please contact Bob Blaskiewicz .

If you are hanging out here at the JREF, you probably already know that learning is fun. However, if you do need some convincing, you can always take a college class all about aliens.

While I was a graduate student at the University of Virginia, I had the great opportunity to teach an astronomy class during the summer of 2010. My first choice was a 300-level class for undergraduates called "Life Beyond Earth." The original syllabus was created by Robert Rood, a longtime UVa professor who passed away last winter. With guidance from him, Ed Murphy, and Joleen Carlberg, all previous instructors of the class, I was able to cobble together my own version of this popular course using the textbook *Life in the Universe* by Jeff Bennett and Seth Shostak. Believer or skeptic, scientist or sci-fi fan, we all love to ponder the possibility of the existence of "someone out there," but can we study it in a reasonable, scientific way?

The hook may be SPACE MONSTERS, but the content of the class is science. The syllabus brought in aspects of astronomy, biology, spaceflight, and skepticism for a fast-paced, one-month summer class. A convenient way to structure the discussion is to use the famous Drake Equation. This says that the number of intelligent civilizations that we may contact in the galaxy can be calculated if you know a number of factors, such as the star formation rate in the galaxy, the number of habitable planets, and the lifetime of an intelligent civilization. Obviously, most of these factors are pure speculation at this point, and the Drake Equation is much maligned for some for not being "accurate." Well, most people don't realize that this equation was not meant to be a rigorous mathematical treatment of the subject, but was written down by Frank Drake in 1961 as a way of organizing the very first conference on the possibility of finding radio signals from extraterrestrial civilizations. So it works quite well as a syllabus guideline, too.

[Image: Plaque.jpg] The astronomy content is fairly straightforward. Our Milky Way Galaxy makes about one solar mass worth of a stars per year. As stars form, planets form in disks around them. Although extrasolar planets were long theorized to exist, they weren't actually

discovered until the 1990s. If I go ahead and check my Exoplanet app , the current total of confirmed exoplanets as of this writing is... 820. Now, how many of these are habitable? Well, it depends on your definition of habitable, and that is where things start to get really fuzzy. Even if you go for "Earth-like" planets, we still have yet to truly find Earth's twin, though the Kepler mission is well on its way to giving us a better estimate of the number of Earth-like planets in the Galaxy.

Given a planet on which life can arise, you can start to talk about the origins and evolution of life itself. We have one glorious experiment to draw upon, that of our own home planet. Though we really don't know what alien life would be like, I'm pretty convinced that they aren't going to be humanoids with bumpy foreheads. The biologists point out time and time again that life could have taken so many different pathways, body plans, and even chemistries. The best we can do is study the science of life on this planet and explore its many varieties and extremes. This is the part of the class where I add a disclaimer that I am NOT a biologist by training, but I do the best I can. In fact, this class may be better co-taught by a biologist and an astronomer to cover all your bases.

The rest of the Drake Equation involves a bit of sociology as well. The last factor, according to Drake, is probably the most important for determining if we'll be able to contact intelligent life with our radio telescopes. That is, how long does a civilization survive? Are we destined to blow ourselves to bits before becoming a spacefaring species? Will we destroy the ecosystem and ourselves with it? Carl Sagan notably said; "It is our fate to live during one of the most perilous and, at the same time, one of the most hopeful chapters in human history." How have other civilizations, if they existed, dealt with this crisis?

Another aspect of the class that is of interest to skeptics is the lesson on UFOs. Most people coming into this class have probably seen a TV special or two on "ancient aliens" or "unidentified flying objects" or alien abductions, and so they have heard of the concepts. But are they really well-versed in this history of the alien saga since the 1940s? Probably not. Skeptics, however, can provide that bit of knowledge. My assigned reading for this part included the Juni or Skeptic issues that cover UFOs and abductions. Delving into the history of the events such as the Roswell crash, which didn't really become a widespread belief until a rather credulous book was published in the 1980s, is quite enlightening. You probably won't convince a believer in the span of one or two college lectures, but it helps to dispel some of the misinformation and give them skeptical resources on these topics.

Another one of my favorite alien topics is the Fermi Paradox. It comes from a lunchtime

conversation involving physicist Enrico Fermi about these new-fangled UFO reports and whether we should reasonably expect to be visited by aliens from other parts of the galaxy. After all, it has been over 13 billion years since the universe was around, and a generation of stars that predate our sun should have been able to form planets, and thus life. The galaxy is of a finite extent, therefore it is reasonable to assume that someone should have whizzed by in a spacecraft by now. But as I mentioned, the quality of evidence for extraterrestrials visiting Earth is paltry at best. So where is everyone?

There are many possible answers that fall into three main categories: they don't want us to know about their existence, they never made it across the galaxy, or we are the first spacefaring civilization. None of those are particularly comforting thoughts, and we have no evidence of any particular scenario. However, it is an interesting thought experiment that is surely responsible for thousands of hours of intellectual conversation. After 50 years of searching the skies with radio telescopes, after 4.5 billion years of life on this planet with no sign of otherworldly visitors, it is a disquieting notion that the galaxy SEEMS so quiet.

I'm not giving up hope just yet that we're all alone in the cosmos. My students were all pretty hopeful as well by the end of the class. The galaxy is probably teeming with life, at least at the microbial level. Science tells us that life, even our single sample of Earthly life, is hardy and opportunistic. So that alone is a fascinating prospect. But will be ever make contact with cogitating beings? We can only imagine the possibilities. And make sci-fi movies about them.

The speculation about the existence of extraterrestrials is wide and vast. However, the discussion CAN be grounded in science and rationality. It fascinates me as an interdisciplinary topic and as one that draws in interested students with a provocative topic that has such rich educational potential.

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. Her thesis focused on radio astronomy instrumentation. Many thanks to Robert Rood, Ed Murphy and Joleen Carlberg!