TEACHING ASSUMPTIONS: THE MISSING COMPONENT OF THE SCIENTIFIC PROCESS. Horodyskyj, L.[1], Mead, C.[1], and Anbar, A.[1], [1]Center for Education Through eXploration, Arizona State University, Tempe, AZ 85287

Introduction. What is science? In most introductory-level science courses, instructors attempt to address this question early in the course through the introduction and definition of key vocabulary terms such as "hypothesis" and "theory", discussing the importance of reasoning and experimentation, and using lab exercises to teach construction and testing of models. Observations are central to all of science and this is emphasized in all definitions of science. Students demonstrate mastery of the "scientific process", however, by repeating these definitions back to the instructor and perhaps executing a few lab experiments.

Unsurprisingly, this approach has resulted in students leaving introductory science classes with a poor grasp of the underpinnings of the scientific enterprise. Not only are many of these definitions opaque and unintuitive to students, but courses are rarely structured in ways that engage students in scientific thinking. Often, mastery of existing scientific knowledge is emphasized, while the process that generates it is disconnected and minimized (i.e., science lecture courses are 3 credits while separate lab courses are 1 credit).

In the transition to teaching science lab courses online, through our 4-credit astrobiology lab course *Habitable Worlds* offered at Arizona State University since 2011, we have built and refined an innovative pedagogy that includes short 5-minute lectures, interactive exploratory and experimental activities, short readings, and problem sets remixed to create dynamic and engaging learning experiences. Yet despite these innovations, various lines of evidence (personal observation, analytics data, pre/post-surveys) suggest that although students like and enjoy the content, they don't demonstrate a deeper understanding of how the scientific process generates knowledge, even when engaged in those processes through the course structure.

We propose that a key missing component in teaching the scientific process is the importance of "assumptions" in scientific work.

Towards a Better Definition of Science. Informal observations of scientists at work reveal a key difference in the language scientists use when brainstorming ideas versus presenting results. When brainstorming, scientists use conditional language such as "presume" and "assume". When presenting results, they use concrete, observational language (i.e., "observed", "saw", "data", "recorded"). Yet despite this reality of scientific work, students are never explicitly told about assumptions nor the role they play in the generation of scientific ideas (as "placeholder observations" until actual observations can take place). In current definitions of science, observations are central to good scientific work. Inferences exist to link observations together, but have a firm logical basis. Personal experiences, guesses, and traditional knowledge play no role in proper science, even when forming initial ideas.

We propose elevating "assumptions" to the same level of importance as "observations" when discussing the scientific process. Assumptions can range from guesses and intuitions ("assume no oxygen in the Hadean") to simplifying ideas ("assume no clouds in this model") to personal beliefs ("assume aliens exist and colonize the galaxy exponentially"). *Assumptions* and *observations*, linked to each other via logical *inferences*, become co-equal in the building of scientific *models*. The dominance of assumptions versus observations in a model determines whether that model is more *hypothesis* (assumption-dominated) or *theory* (observation-dominated).

Benefits of Approach. We expect several key benefits to teaching science by highlighting the interplay between assumptions and observations in developing scientific knowledge.

Accessibility. Observations and assumptions are common everyday behaviors, unlike "hypothesis construction", and accessible to non-science students.

Simplicity. The words "hypothesis" and "theory" become more intuitively and simply defined compared to current definitions.

Utility. Introducing scientific concepts using this framework can help students see how scientific ideas are constructed, the level of confidence in those ideas, and areas of ongoing and future research.

Unity. This framework is easily applicable to both experimental and observational science, which is especially important to astrobiology considering that geology and astronomy have considerable observational components that are often dismissed as "not subject to the scientific method" (because of the lack of wet-lab components).

Diversity. Assumptions stem from the diversity of human thought and experience. Although assumptions are emphasized in "nature of science" research, they are often ignored in "nature of science" teaching in favor of focusing on impartial observations divorced from personal experiences, which can be alienating to many students.