IMPACTS OF ASTROBIOLOGY LESSONS ON MIDDLE SCHOOL STUDENTS. L. Coleman[1], T. J. Mackey[2] , M. Krusor[2], D. Y. Sumner[2]. [1] Twelve Bridges Middle School, Lincoln, CA 95648, lcoleman@wpusd.k12.ca.us [2]Department of Earth and Planetary Sciences, University of California, Davis, 1 Shields Avenue, Davis, CA 95616 tjmackey@ucdavis.edu.

Introduction: Nothing strikes interest in the minds of middle school students more than learning about Earth and Space Science. Additionally, asking whether we are alone in the universe is a curiosity that defines our species. The middle school years represent a golden opportunity to use this question as a way of understanding the nature of science; that we ask many smaller questions that help us understand the bigger question. There are many resources and lessons on astrobiology available to guide students through the inquiry process. However, we need to measure the learning achievements of the students, critically examining the effectiveness of the teaching strategies.

Here, I present a study of middle school astrobiology lessons and their impact on student understanding of the nature of science. The broad goals for students are:

- to understand the current major foci of the field of astrobiology.
- to understand the interplay of science, technology and engineering
- to inspire interest and pursuit in STEM careers

The Lessons:

Lesson 1: Students engage in an investigation of extremophiles, matching their environments with extraterrestrial environments within our solar system. (http://marsed.asu.edu/content/xtreme-o-philes) The lesson aligns with Next Generation Science Standards (NGSS) that focus on interactions between living and nonliving systems.

Lesson 2: Students evaluate Antarctic environments including but not limited to the McMurdo Dry Valleys as an analog for environments on Mars and Europa. Lessons 1 and 2 provide a framework for understanding the areas of current, active research and also highlights scientific career pathways.

Lesson 3: Students build winogradsky columns that explore communities of microscopic organisms and explore reasons why extraterrestrial lifeforms are more likely to be microscopic. This leads to an examination of the differences between what life is possible vs. what's probable.

Lesson 4: Teams of students use the Astrobiobound activity (http://marsed.asu.edu/lesson-plans/astrobiobound) to create their own astrobiologically-focused mission to either Mars, Europa, Enceladus, or Titan and must balance the budget, power, and engineering constraints to achieve their science goals. Further, this lesson captures the intersection of science, technology and engineering and aligns with NGSS standards related to engineering and life science.

Figure 1: Lake Joyce, Dry Valleys, Antarctica with surrounding topography and environment. L.Coleman

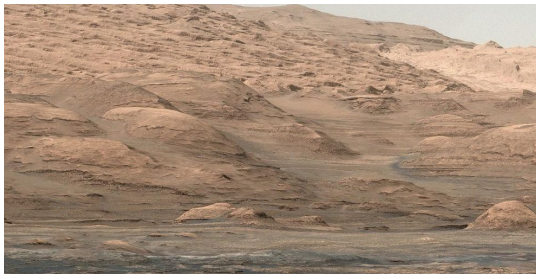

Figure 2: Mount Sharp Buttes and layers from near Darwin, Mars. Courtesy of NASA/JPL-Caltech/MSSS

Measuring Outcomes: Assessment and revision of the lessons is ongoing. Anecdotally, these lessons were of very high interest to students, who remained actively engaged and curious throughout the series. In addition, a series of metrics were applied to quantitatively assess the impacts of these lessons, including self-reports of interest in science generally and astrobiology in particular and surveys of content knowledge before and after lessons were implemented. These assessments reveal that students have a deeper understanding of science and engineering practices. Further, the assessments capture student understanding that it's the nature of science to ask many, many smaller questions so that we can better understand the bigger question of whether life could exist elsewhere.