

**Nature of Science & Math**  
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### **Scientific Knowledge is Based on Empirical Evidence**

With publication of *In Coral Skeletons, Microscopic Portraits of Resilience?* (Yin 2017) Dr. Falkowski is making a claim that suggest carbon emissions from fossil fuel burning is the cause of warming and acidification in our oceans. This claim is only able to stand ground based on the amount of evidence Dr. Falkowski and his colleagues were able to gather. This claim also supports NGSS Nature of Science tenet, Scientific Knowledge is Based on Empirical Evidence (NGSS Release 2013). In order for these scientist to make claim, such as the one above, they had to gather substantial amount of empirical evidence. Referring back to the article:

Dr. Falkowski and his colleagues used ultrahigh-resolution microscopic imaging and techniques for observing the structure of molecules to study skeletal branches from smooth cauliflower coral, a well-studied species in the Indo-Pacific.

If one were to take a walk into the laboratory of these scientist, an eye would see scientists making observations, including observations with the use of technology to make observations. Another example in the article “When we precipitate aragonite in the lab, just in a bucket of seawater, it forms this very characteristic pattern with very long, needle-shaped crystals.” When looking into a NGSS table *Understandings about the Nature of Science*, there is more detail about each tenet of NOS, one detail which states “Science includes the process of coordinating patterns of evidence with current theory.” Now, Nicola Allison (Yin 2017), clearly noticed a pattern connection when observing aragonite in the lab. This article has evidence that support the NOS tenet Scientific Knowledge is Based on Empirical Evidence.

### **Scientific Knowledge is Open to Revision in Light of New Evidence**

Additionally, the same article sheds light on another NOS tenet, Scientific Knowledge is Open to Revision in Light of New Evidence. Initially, the article (Yin 2017) begins describing the human driven ocean acidification and how it affects coral reefs. Then, the article provides two opposing views on the matter at hand:

One view prioritizes...Under these circumstances, if oceans become more acidic coral may struggle to form a skeleton.” “The alternative view contends that calcification is primarily a biological process.” Finally, “The new study provides evidence for this perspective and some hope for corals in a world with more carbon.”

There are clearly different opinions, and each opinion has evidence to support their claim. So, what happens next? What happens when different claims both have supporting evidence? To me, when new evidence has been observed, this knowledge opens revision to previous knowledge. In a larger scope, although science is reliable, scientific knowledge cannot be a construction to new evidence, because science is forever changing.

### **Science is a Human Endeavor**

Originally, as I was looking through the tenets deciding which one supported this article the best. At first glance, the Human Endeavor tenet was not one I thought the article support at all. In the article, there's no evidence of imagination and creativity. I also found nothing supporting the scientist being from many nations and cultures. As I read the article one last time, a sentence in the one of the first paragraphs in the article stood out to me "A study published in Science on Wednesday now presents a microscopic pictures of the biology..." (Yin 2017). This statement does support the Human Endeavor, because "technological advances have influenced the progress of science and science has influenced advances in technology" (NGSS Release 2013). Technology is fast changing and because of this, new science discoveries are revealing change as well.

### **Construct viable arguments and critique the reasoning of others**

In this article, *In Coral Skeletons, Microscopic Portraits of Resilience?* (Yin 2017), there are two arguments. One argument states "a potential consequence of human-emitted carbon dioxide in the atmosphere being absorbed by the seas — coral may struggle to form a skeleton. Referring to *APPENDIX L – Connections to the Common Core State Standards for Mathematics*, when constructing arguments, "one should justify their conclusions by building a logical progression of claims and using examples. It's also important that they be able to distinguish correct reasoning from that which is flawed." (Manegold 2013). Dr. Falkowski responds to this beginning statement by saying "It's true that corals lose calcium in a more acidic environment — but they maintain the ability to grow back that skeleton." Here, Dr. Falkowski is critiquing the opening statement about corals struggling to form a skeleton under such condition.

### **Attend to precision**

In short, the article supplies the reader with multiple examples of precision. Alexander Venn states "...We have lots of data that show many coral species are very sensitive..." Referring back to the article "Dr. Falkowski and his colleagues used ultrahigh-resolution microscopic imaging and techniques for observing the structure of molecules to study skeletal branches from smooth cauliflower coral, a well-studied species in the Indo-Pacific." Using such technology absolutely

requires the most attention and precision. Lastly, Allison, forming precipitate of aragonite in the lab, definitely required precision and attention to detail.

### **Look for and make use of structure**

Dr. Falkowski states “At the end of the day, the fundamental rules of chemistry and physics still apply.” He is able to discern patterns from his very specific topic back to a general science fundamental concept. Being able to understand patterns, Dr. Falkowski is able to see a bigger picture here and analyze the larger problem at scale, which is carbon emissions from fossil fuel burning warming and stressing the algae living inside corals and causing coral bleaching.

Steph Yin (2017). *In Coral Skeletons, Microscopic Portraits of Resilience?*

<https://www.nytimes.com/2017/06/01/science/coral-skeletons-ocean-acidification.html>

NGSS Release (2013). *APPENDIX L – Connections to the Common Core State Standards for Mathematics.*

[http://www.nextgenscience.org/sites/default/files/Appendix-L\\_CCSS%20Math%20Connections%2006\\_03\\_13.pdf](http://www.nextgenscience.org/sites/default/files/Appendix-L_CCSS%20Math%20Connections%2006_03_13.pdf)

Neal Manegold (2013) *Explaining CCSS standards for mathematical practice.*

<http://www.dreambox.com/blog/explaining-ccss-standards-for-mathematical-practice>

NGSS (2013) *APPENDIX H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards.*

<http://www.nextgenscience.org/sites/default/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf>