

Laura Antunez Rodriguez

June 10th, 2019

Methods of STEM education

THE NATURE OF SCIENCE

Analyzing the presence of the Nature of Science & Math in the article: *In Coral Skeletons, Microscopic Portraits of Resilience?*

<https://www.nytimes.com/2017/06/01/science/coral-skeletons-ocean-acidification.html?ribbon-ad-idx=8&rref=science&module=Ribbon&version=context%2%A&Eion=Header&action=click&contentCollection=Science&pgtype=article>

PART A.

Scientific Investigations Use a Variety of Methods

In the article *In Coral Skeletons, Microscopic Portraits of Resilience?*, it is described how scientists use a variety of methods to study corals. The first method the article refers to is observation “coral reefs are sprawling, intricate ecosystems”. Some more advanced methods that are cited throughout the text, such as ultra-high resolution microscopic imaging and techniques for observing the structure of molecules to study skeletal branches, are only possible nowadays thanks to the development of new technologies.

Parallely, students in high school will be expected to understand how scientists use diverse methods, instruments and new technologies to revise, produce, rebate and report new findings.

Scientific Knowledge is Open to Revision in Light of New Evidence

The article *In Coral Skeletons, Microscopic Portraits of Resilience?* starts by pointing out that “ a study published in Science on Wednesday now presents a microscopic picture of the biology that makes coral’s skeletons grow. The findings suggest...” This first paragraph of the article is an example of how scientific knowledge is open to revision. I purposely underlined the word “now” just to show how scientific knowledge is open to be revised under new evidence. The discovery of new evidence adds new information to what we know and challenges scientists to

rethink about how corals really grow, adding a new layer of complexity to our scientific knowledge.

The article also shows how scientists are debating whether the most important process for coral growth is chemical interactions with seawater, or if, on the contrary, biological processes are primarily responsible for the growth of coral skeletons. Nature of Science Matrix (2013) captures this important idiosyncrasy of science. It is expected by High School students to be able to understand how scientific knowledge is subject to change, and how scientific argumentation is a mode of logical discourse. This article offers two different scientific perspectives: one based on the chemistry of calcium carbonate and carbon dioxide, and another, based on biological controlled-processes.

Scientific Knowledge is Based on Empirical Evidence

The article *In Coral Skeletons, Microscopic Portraits of Resilience?*, shows two different approaches to the question, how do corals grow?; both of these approaches are evidence-based. On one hand, Dr. Falkowski and his team discovered, through the use of microscopic imaging technique, that amorphous calcium carbonate is formed in the initial stage, by protein. On the other hand, scientists, such as Alex Gagnon, using chemistry principles, point out how chemical reactions help form or dissolve corals' skeletons.

As we can see, the article offers a variety of opportunities to make connections between the work of scientists and three of the major themes about the nature of science proposed by NGSS. To me, the most important goal of NGSS is bringing this true nature of science to the classroom. Based on the principles that every child is able to think, investigate, focus on core ideas and learn as a scientist (A Framework for K-12 Science Education, 24), bringing the nature of science to the classroom is to find a domain of learning outcomes for students in all grades (Nature of Science in the NGSS, 2013). Expectations for students in the classroom perfectly mirror what scientists do in the real world; scientists use a variety of methods to carry on scientific investigations, scientific knowledge is based on empirical evidence and paradigm shifts can happen in light of new evidence (Nature of Science Matrix, 2013). At the end of the day, science is the way we explain what we know about the world. To ensure that our students become

scientific literate, we must not dilute science, we must bring science to the classrooms as it is. The Nature of Science Matrix shows how the understanding of the scientific knowledge deepens as students move from K2 to High School. This is also a characteristic of science: science moves from simple to more complex knowledge; each time that we discover new evidence on an idea that was already known, such as how coral's skeletons grow, we add a layer of complexity to our scientific knowledge. As students grow up and move from the lower to the upper grades, students are expected to increase their level of understanding in science. Students go from looking for patterns, and have a basic understanding of how knowledge can change when new information is found in K2, to adding multiple lines of evidence to support an explanation, drilling deeper in scientific inquiry, and using complex scientific argumentation in K12 (Nature of Science Matrix, 2013)

PART B

Make sense of problems and persevere in solving them

Mathematically proficient students are able “to consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution”(Standards for Mathematical Practice). In the article *In coral Skeletons, Microscopic Portraits of Resilience?*, scientists discovered that amorphous calcium carbonate is initially formed by proteins and that this very same process can be observed in sea urchins and shellfish. Scientists in the article are trying to gain insight of the evidence they found by considering simpler forms of the original problem (sea urchins and shellfish). Scientists in the article also predicted that ocean's acidity will keep increasing due to human-emitted carbon dioxide in the atmosphere. In the same way scientists make use of equations and relationships to search for patterns or trends, students are expected to be able to “explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends” (Standards for Mathematical Practice)

Construct viable arguments and critique the reasoning of others.

“Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples” (Standards for Mathematical Practice). *In the article In Coral Skeletons, Microscopic Portraits of Resilience?*, Alexander Venn, a senior scientist, points out “While this paper builds a strong model for the biological control of calcification, there are still pieces of the puzzle missing”. However, “Alex Gagnon, an assistant professor, suggested it was an oversimplification to take seawater chemistry out of the equation”. This is an example of how scientists read the arguments of others and are able to engage in scientific discussion to improve, clarify or ask questions.

Model with mathematics.

In the article *In Coral Skeletons, Microscopic Portraits of Resilience?*, we can read about how scientists developed a model of coral calcification, observed a very long needle-shaped crystal pattern, establish that many coral species are very sensitive to environmental changes, or apply fundamental chemical equations to determine how acid dissolves calcium carbonate. All in all, these are ways in which scientists have used mathematics to solve problems arising in society.

To conclude, doing this activity has open my mind to the great possibilities that common core and NGSS are bringing to the classroom. Teachers have been looking for years for ways to make their classes more meaningful and authentic. Well, what is more authentic than bringing real science, scientific knowledge and scientific practice to our classroom? I finally feel that our students will be able to feel as researchers and scientists in our classes. By bringing this way of thinking to our classes I am sure that we are helping our students to understand a world of interconnectedness and to expand their minds to become problem-solvers. As the Framework for K-12 Science Education establishes “students are born investigators”. It is our job now to nurture and expand the intellectual curiosity our students bring to our classroom.

References

- 1) Common Core State Standards Initiative. (n.d.). Standards for Mathematical Practice. Retrieved from <http://www.corestandards.org/Math/Practice/>
- 2) National Research Council, Division of Behavioral and Social Sciences and Education, Board on Science Education, & Committee on a Conceptual Framework for New K-12 Science Education Standards. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: National Academies Press.
- 3) NGSS Public Release II. (2013, January). Retrieved from nature of science matrix <https://www.nextgenscience.org/sites/default/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf>