

There are currently 8 tenets of science that are taught in schools following the NGSS. In this essay, I will explain how I address each tenet, how I can improve on student experience when they are applying them, and identify the tenets of technology that overlap those of science.

Tenet 1: Scientific Investigations Use a Variety of Methods:

In Y10 Biology, students model the famous peppered moth experiment using a black and white background that mimics the trees, paper moths (special hole punch) that play the role of the peppered moths, and a pair of forceps imitating the beak. Students have to design their own proper investigation to model natural selection, collect the data, graph it and interpret it using a scientific explanation. Also, when calculating reaction rates regarding the decomposition of hydrogen peroxide using liver, I show students various procedures they can use to collect quantitative data. I also encourage them to come up with new methods when measuring reaction rates.

Improvements: Right now, students are only using a variety of methods in only a few investigations. I need to work on expanding this notion to many more labs, to scaffold the first ones but give them a lot more freedom later on in the year.

Tenet 2: Scientific knowledge is based on empirical evidence

In Y10 Biology, in the form of a gallery walk, students investigate all the evidence scientists use to explain the theory of evolution. Students are always the most surprised when learning about embryology. I believe it's also a piece of evidence that is most relatable to them. I'm also lucky that my school administrators support STEM education and have not been asked to change the curriculum, or to use the word adaptation instead of evolution.

Improvements: In Peters Burton editorial *Is there a nature of STEM*, the author mentions that 'scientists use evidence and logic to make claims that explain the workings of nature to the best of their ability'. I have students collect their own data often, but we don't look at data that other scientists have collected very often. I would like to introduce this content to my students more often to enhance their understanding when using a wide array of evidence when making a scientific claim.

Tenet 3: Scientific Knowledge is Open to Revision in Light of New Evidence

Unfortunately, I don't give many examples following this tenet. There are many examples of this tenet being applied in Space, most notably the debate on whether Pluto is a planet or not. I will have to look into it further as examples in other fields of the Sciences, such as the life sciences. I do however stress to students that science is a dynamic discipline and in light of new evidence, scientific hypotheses do change. I just have to find more case studies to show them.

Tenet 4: Science models, Laws, Mechanisms and Theories explain Natural Phenomena

I teach all of the above separately.

Improvements: To teach them in a more dynamic and connected way, somehow. I don't have many ideas at the moment. I will have to work on this tenet in the summer.

Tenet 5: Science is a Way of Knowing

According to Appendix H, 'Science is both a body of knowledge and the processes and practices used to add to that body of knowledge'. In Y10 Biology, when I teach Genetics, students learn the basics of genetics and protein synthesis (approx. 4 months). Once they have a solid understanding of the unit, then we move on to biotech topics such as antibiotic resistance, gene editing, CRISPR, etc. Students are made aware that science is a work in progress and scientists build on the knowledge and models from others to advance scientific progress. Molecular scissors wouldn't have existed without the work of scientists from all around the world going back to the Father of Genetics: Mendel

Tenet 6: Scientific Knowledge Assumes an Order and Consistency in Natural Systems

According to Appendix H, 'Science carefully considers and evaluates anomalies in data and evidence'. I tell my students that if they fudge the data, they will lose their scientist license. Outliers and explanations as to why they occur need to be considered. It gets students to think about potential errors in their data set and that science is not perfect and can be messy, and that's ok, that's what makes it great.

Tenet 7: Science is a Human Endeavor

In Peters Burton editorial *Is there a nature of STEM*, the nature of stem is 'characterized by the human endeavor of anticipating outcomes based on background knowledge, making sense of what is observed'. Students have a hard time with this concept as they struggle with explaining the science behind their data. I repeat to them that SCIENCE IS YOUR FRIEND, use it to figure out the why of your data regardless if the hypothesis is supported or not. Another challenge as teachers is to teach the complexity of a scientific topic without disengaging the students or worse oversimplifying it. I tell students that Science is hard but that's a good thing, not all are convinced.

Improvements: As a science team of teachers, we will be working on creating a list of scientists (dead/alive, men/women, and of various cultures including Spain where I teach) to show the wide variety of talent that exists in STEM fields.

Tenet 8: Science Addresses Questions About the Natural and Material World.

According to Appendix H, 'Science knowledge can describe consequences of actions but is not responsible for society's decisions'. Every Friday, we start class with an event called Science Friday where we read through the headlines of the weekly science news from the *Nature* newsletter. Students enjoy this because they can see how science can affect their every day lives just like other news events. Naturally, with covid, came a massive vaccination campaign, and along with that, anti vaccination movements that made the news very often. This showed how many governments following scientist recommendations kept their citizens safe and promoted vaccination campaigns to keep people out of the ICUs. Unfortunately, many aspects of society followed misinformation online and chose not to protect themselves or others. Common sense media has a list of red flags that can help internet users navigate false claims. I give students a list of websites, some credible, some not, on covid and they have to figure out

based on the list, which sites are misleading and which ones are based on sound scientific evidence.

Improvements: Include such activities about other common misconceptions such as cancer cures.

Overlap with the tenets of Science and Technology

I decided to choose the Tenets of Technology as an overlap with those of Science.

1. Most technological development has been evolutionary, the result of a series of refinements to a basic invention.
This tenet of the Nature of Technology overlaps with the tenet that scientific knowledge is open to revision in light of new evidence. Whether we are referring to technological or scientific innovation, both are constantly being refined and built upon to enable progress.
2. The use of technology affects students in various ways including their safety, comfort, choices, and attitudes about technology's development and use. This tenet of the Nature of Technology overlaps with the tenet that Science is a Human Endeavor. Science and Technology both influence society and are influenced by society.
3. Many inventions and innovations have evolved by using slow and methodical processes of tests and refinements. This tenet of the Nature of Technology overlaps with the tenet that Scientific Knowledge is based on Empirical Evidence. Both technology and science are interlinked as they never stop evolving and are based on evidence and team work, which as a result enables progress.

The Nature of STEM as a dynamic concept

In conclusion, the Nature of STEM is a dynamic notion, one that is changing as time goes on. In Peters Burton editorial *Is there a nature of STEM*, the author claims that 'One side (NOE and NOT) is the study of humans influencing the world, and the other (NOS and NOM) is about humans understanding the mechanisms in nature. Based on this definition, it's in our human nature that we push the limits of innovation, whether ethical or not and deal with the consequences later. As scientific knowledge accumulates and becomes more vast, technology will follow suit as these two are interrelated, and so the nature of STEM will change as well based on the content and skills we want the future generations to acquire.