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History and Nature of Science Lesson Plan Reflection
NSTA Standards 2a-b, 3a, 4a, 7a

The purpose of this lesson is to show students the advantages and shortcomings of technology in solving scientific problems and building evolutionary trees. The students will build an evolutionary tree based on morphological traits, and then one based on genome sequencing. A historical look on Lamarck and Darwin will be used to explain the evolution of the phylogeny tree and how scientific views of evolution have changed throughout time. To elaborate on the use of technology in the 21st century, the students will complete a bioinformatics lab in which they use genome sequences of different plants to determine which plant made an Appalachian Trail hiker sick. They will then use ClustalW to see the computers building an evolutionary tree of their plants, and learn the difference between cladograms and phylograms. Finally, the students are asked to evaluate the limitations of technology in building evolutionary trees based on fossil records, such as that of dinosaurs, or early hominids.

2a Understand the historical and cultural development of science and the evolution of knowledge in their discipline.

The history of evolutionary trees is emphasized in this lesson. Carl Linnaeus, Lamarck, and Charles Darwin and the three main historical scientists discussed. The students will see a progression of thought from one scientist to another, allowing them to appreciate "how we know what we know" today. A recent history of technology and genetics is emphasized to show that scientists are still making discoveries, and they will continue to make discoveries.

2b Understand the philosophical tenets, assumptions, goals, and values that distinguish science from technology and from other ways of knowing the world.

Science and technology have a very integrated relationship. The human brain is the ultimate technology that allows us to advance in science, but most would argue that it is not a technological tool. The students get to experience a unique situation in this lesson, where they are able to tackle the same problem (classifying a group of organisms), as a 19th century scientist and then a 21st century scientist. In this exercise they will see how a recent technology (genetics) has been such an important tool in making advancements in classification. In the elaborate section of this lesson, they see how genetics can go beyond simple classification and be used to solve problems in a bioinformatics lab.

Most students have the misconception that more sophisticated technology is directly correlated to better understanding in science. This is not necessarily true. In order to show them otherwise, the class discusses the limitations of technology. A good example of this is classifying fossilized remains that lack the DNA necessary to use genetic classification. In the case of bones, scientists use their knowledge of anatomy to help them build evolutionary trees that could not otherwise be built with advanced technology.

3a Understand the processes, tenets, and assumptions of multiple methods of inquiry leading to scientific knowledge.

In this lesson, the students use three methods to classify organisms; by morphologic comparison, comparing nucleotide base sequences, and using technology. This allows them to see how technology has helped in classification processes in recent times. In math, students are given a long, tedious way to solve a problem and then they are given the short-cut formula afterwards. Although they complain grudgingly, they learned the "why" and "how" behind getting the answer. Comparing nucleotide base sequencing is the how the computer does it, but by doing it first-hand, they can see how much time and energy is saved with programs like ClustalW and NCBI Blasting.

4a Understand socially important issues related to science and technology in their field of licensure, as well as processes used to analyze and make decisions on such issues.

It goes without saying that evolution is a sensitive subject in school systems. Although it is debated, it is pretty grounded within the scientific community and should be taught in the school systems. This lesson teaches evolution without really having to discuss evolution to a great degree. The engage activity requires students to place the face of the great ape on where they think it goes on an evolutionary tree that just has the branches. This relationship is based on genetic sequencing, a sound method in building cladograms. The instructor does not need to mention how these relationships came to be or why, just that they are.

The history of the evolutionary trees is not the same as the history of evolution, although the two overlap. If a teacher is uncomfortable teaching evolution, they could use lessons like these to "touch on" evolution without blatantly talking about it. The instructor may also use phrase like, "small changes over a long period of time," if they wished to elaborate on Darwin's theory of natural selection.

7a Identify ways to relate science to the community, involve stakeholders, and use community resources to promote the learning of science.

The elaboration portion of this section is a bioinformatics lab. The first section of this lesson allows the students to work as a class to solve a problem. They are given a scenario in which an Appalachian Trail (AT) hiker has eaten a plant and become very sick. They then use the NCBI website and other resources to determine which plants they have found and which plant made the hiker sick. This is very relevant to student's who live near the AT and gives the student's a sense of purpose and importance in the lab. They may even take this information with them when they go hiking so they know which plants are edible and which ones aren't.