

What is progress?
Astronomy
Lesson 1

Does anyone know what progress is? [Brainstorm a definition]

Ask someone to look the definition up in the dictionary.

- Forward movement (Merriam-Webster)
- A gradual betterment (M-W)
- To move forward (M-W)
- To develop toward a more advanced stage (M-W)
- Development or growth (American Heritage)
- Steady improvement as of a society or civilization (Am. Her.)
- To advance or proceed (Am. Her.)
- To advance toward a higher or better stage (Am. Her.)

What about these definitions?

The advance or growth of modern, industrialized society, its technology and its products or goods.

The progress of society is that which makes the society better in the general view of those who attempt to cause it (the progress).

What do you all think of these definitions? Do they seem a little one-sided?

[If they need more prompting – What about the definition of progress within a society? What if we make society worse for the people who don't want progress? Is it still progress? For instance: the development of nuclear reactions was extremely progressive, however this development allowed for the development of nuclear bombs – is the destruction of hundreds of thousands of people progressive? Is the fallout of nuclear radiation on the environment, causing death and destruction progressive?]

This is a question we're going to spend the year trying to answer: What is progress? And, how can we contribute to progress in a sustainable way?

In order to try and answer this question we're going to look at many different historical, social, and scientific situations and try and determine why they were or were not contributors to progress, and how they contributed. We'll be looking at these situations from many perspectives in order to try and make informed judgments and accurate analyses.

One of the first situations we'll be looking at is the shift from a geocentric view of the universe to a heliocentric one. Does anyone know what those words mean? What does geo mean? And helio?

The Scientific Revolution, which lasted roughly from 1543 CE to 1800 CE, is the change from the belief that science should be rooted in philosophy and deep thinking, the Greek way of doing science, to the belief that science should be based on experiment, observation, and measurement. As technology changed and improved and forms of measurement became more exact, scientists developed a method for forming questions, developing experiments, and reasoning about observations—this method is the scientific method, and you will find that most branches of science strictly follow the scientific method when forming ideas and reasons for the great unknowns of the universe.

By the 7th Century BCE, a common viewpoint had arisen in Greece that the Universe is a rational place that follows rational laws, and we (human beings) should be able to figure out those laws. The emphasis was on the process of learning about the universe rather than determining the actual laws. But, people eventually got tired of learning about the laws and wanted to determine the absolute answers of why the Universe behaved the way it did.

Socrates (470 – 399 BCE) thought that we could attain real truth through collaboration with others. Through skepticism of intuitive thought and collaborative exploration we could get a better sense of how our world operates. This idea of skepticism followed by exploration for accurate answers is still very much a part of the modern scientific process.

Socrates' student Plato (427 – 347 BCE) developed Socrates' ideas further. Plato taught that there are absolute truths, mathematics being the principle of those truths. Statements about the physical world are relative to each person, place, and time, but mathematics is independent of those influences. For instance, $2 + 2 = 4$ always.

Pythagoras (569 – 475 BCE) created the first guiding paradigm for the Greeks. (Where have you heard of him before?). (Vocab: paradigm – a general consensus of the way the world works). Pythagoras' Paradigm included three key points about the movement of the planets:

- The planets, Sun, Moon, and stars move in perfectly circular orbits
- The planets, Sun, Moon, and stars maintain a constant speed in their orbits
- The Earth is at the exact center of the motion of the celestial bodies

This faith in order caused the Greeks to try to find explanation for the, seemingly, unordered planets – specifically retrograde motion. So, Plato asked

his students to find a geometric explanation for the apparent motion of the planets, including the seemingly inexplicable retrograde motion.

But, you all know that, in fact, the sun is at the center of our universe, which leads me to think that perhaps some of Pythagoras' other rules about the planets were wrong. So, at some point between 400 BCE and now, there was a paradigm shift in the way we understand our solar system. This paradigm shift was a result of the Scientific Revolution. A single change does not make a revolution. Among the new ideas that were seen to be revolutionary were:

- The replacement of the Earth by the Sun as the center of the Solar System
- The replacement of the idea that all planets travel in a circular orbit by the discovery that all planets travel in an elliptical orbit
- The replacement of the Aristotelian concept that movement requires a constant force by the idea that, once started, an object in motion continues indefinitely w/o need for further force

All of the ideas that were replaced are attributed to Aristotle and his forefathers Socrates and Plato. So, what kinds of ideas did these men have that they needed replacing? And who were the scientists that replaced their ideas? Those are the questions we're going to be answering over the next few weeks...

Here's something to chew on, though: In the twentieth century, scientists found that as they started to gather more information about very small particles, subatomic particles, that the more precisely they measured one property of the particle, say its momentum, the less they knew about the velocity of the particle. They found that it is impossible to measure simultaneously both the position and velocity of a subatomic particle with certainty.

So, the two questions I leave you with today are—can experiment and observation lead to scientific truth? Is there really any certainty in science?

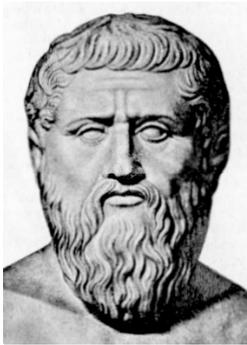
[I find these last two paragraphs to be especially helpful with middle school students, since they often tend to look upon the Greeks as being "stupid" for thinking the Earth was at the center of the solar system rather than the sun, since they've only ever known a heliocentric system. However, introducing the idea of uncertainty encourages them to question the "truths" that they know about astronomy and be more open to the ideas coming up in later lessons.]

Images to use in lesson:



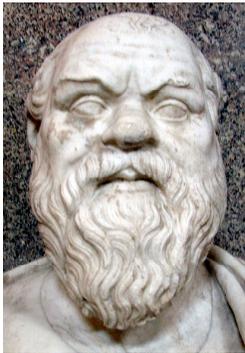
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The Death of Socrates

Jacques-Louis David (French, 1748-1825), 1787
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Pythagoras

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