Learning Progressions: What Are They, and Why Are They Important?

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The twelve core ideas that form the basic structure of the *Next Generation Science Standards* (NGSS Lead States, 2013) start in the earliest grades and culminate in high school. Why is it important for a fourth grade teacher to learn the full trajectory of a core idea if he or she is responsible for just a small part? The answer lies in the concept of a learning progression, which is described in *A Framework for K-12 Science Education* (the blueprint for the NGSS) as follows.

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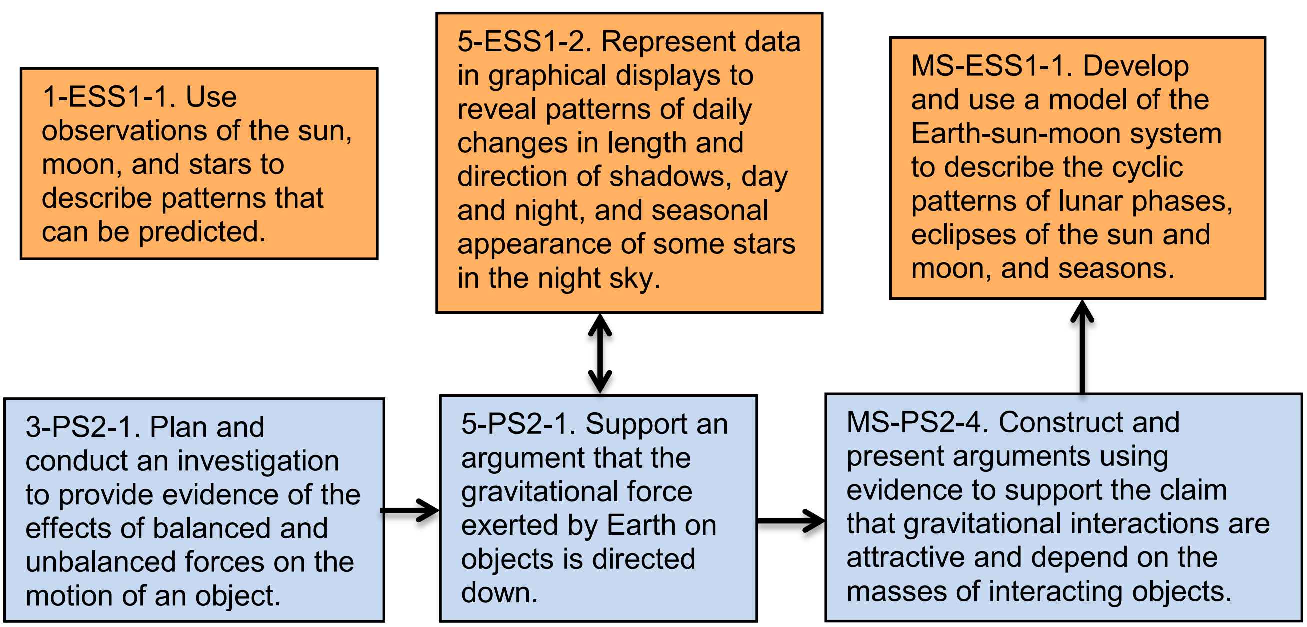
> To develop a thorough understanding of scientific explanations of the world, students need sustained opportunities to work with and develop the underlying ideas and to appreciate those ideas' interconnections over a period of years rather than weeks or months. This sense of development has been conceptualized in the idea of learning progressions. If mastery of a core idea in a science discipline is the ultimate educational destination, then well-designed learning progressions provide a map of the routes that can be taken to reach that destination. Such progressions describe both how students' understanding of the idea matures over time and the instructional supports and experiences that are needed for them to make progress. Learning progressions may extend all the way from preschool to 12th grade and beyond—indeed, people can continue learning about scientific core ideas their entire lives. Because learning progressions extend over multiple years, they can prompt educators to consider how topics are presented at each grade level so that they build on prior understanding and can support increasingly sophisticated learning. Hence, core ideas and their related learning progressions are key organizing principles for the design of the framework. (Framework, NRC, 2012, p. 26)

In a word, we need to understand where our students are coming from, and where they are going, if we are to succeed in helping them progress along their journey from kindergarten to grade 12.

Here's an example from my own research and teaching. As a boy I was fascinated by the mountains and craters on the Moon, the vast size of Jupiter, and the rings of Saturn. I remember learning how to find Orion in the sky while in the third grade and the names of the planets in the fourth grade. However, I can't be certain when I learned that Earth—the planet we live on—is an impossibly huge globe suspended in space that spins on its axis once a day and lumbers in a long slow orbit around the Sun. Although I was passionate about astronomy, all of my attention was focused on what was "up there." I doubt very much if I really understood what it meant to live on a planet. When I eventually chose a career as a science educator I became interested in how and when children develop an understanding of their place in space. Some of that work is described in a book of "probes" that teachers can use to find out what their students know, and need to know, about astronomy (Keeley and Sneider, 2013).

What I learned about astronomy as an elementary student depended on my teachers' personal interests and what might have been in our science textbooks. Today we have the *Next Generation Science Standards* to specify what students should be learning about Earth, the Sun, the Moon, solar system, stars and galaxies beyond. These core ideas are embodied in two interrelated core ideas: 1) Earth's Place in the Universe and 2) Motion and Stability: Forces and Interactions. As shown by the arrows in the diagram below, each of these core ideas develop from grade to grade and there is an interaction between them. It is not possible to fully understand the Earth-Sun-Moon system without also learning about the forces between these bodies—the force of gravity. Let's take a closer look at the learning progressions from the NGSS for grades 1, 3, 5, and middle school.

ESS1: Earth's Place in the Universe



PS2: Motion and Stability: Forces and Interactions

In first grade, students are expected to observe the sky over time and begin to observe patterns. The Sun rises, moves across the sky, and sets every day. The Moon can sometimes be seen in the daytime and sometimes at night; its observable pattern is the changing phase of the Moon over the period of a month. The stars are visible at night, but not during the day.

In third grade, students learn about how balanced and unbalanced forces affect motion. At this level students do not relate these ideas to the motions they observe in the heavens, but developing an intuitive understanding of forces and motion at this level is important for what comes next.

In fifth grade, these two core ideas begin to reinforce each other, since this is the age at which children can begin to appreciate what it means to live on Earth. “Down” is no longer an absolute direction in space, but is directed towards the center of Earth, so that people can live all over the world without falling off. From the perspective of people in Australia, we live “upside down.” Recognizing this, patterns that students see in the sky take on new meaning. The Sun, for example, “rises” because Earth is turning.

In middle school, students are expected to develop a mental model of the Earth-Sun-Moon system so they can use this model to explain and predict the motions of these bodies in space and how they appear from their backyard. They should be able to demonstrate how Moon phases are different from eclipses of the Sun and the Moon, and from what they have learned about force and motion, they should be able to tell why the Moon stays in orbit, neither falling to Earth nor flying off into space.

These are not simple facts. The idea that rules governing the motion of objects around us are the same rules governing the motion of Earth, the Sun, and the Moon in space was Isaac Newton’s profound insight that led to what we now call “modern science.”

Admittedly, the diagram on the previous page is simplified. Several related ideas are left out, and it does not extend to the high school level, which includes the capabilities of applying Newton’s laws of motion in a wider variety of situations, and explaining the evidence that led to the big bang theory of the current distribution and motion of matter in the universe. However, the diagram does illustrate how each step in a student’s science education is essential in preparing the ground for the next major step. Like links in a chain, if one is weak, the entire chain of ideas will not hold together.

References

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