Lower School Science: Building Understanding Over Time
By Debby Knight, Lower School Science Teacher

Throughout their journey at CFS, students engage in a range of scientific practices and disciplines that allow them to develop an increasingly sophisticated understanding of the natural world and their relationship to it. From the time they enter school in Pre-K and Kindergarten until they complete Middle School, students have opportunities to revisit concepts and to build on earlier learning as they explore a variety of topics in science. This process is supported by ongoing conversations among Lower School faculty, as well as between the Lower and Middle School science specialists. This emphasis on building understanding over time is a key tenet of the work leading up to the most recent iteration of standards for science education.
A Framework for K-12 Science Education (2011), which provided the vision for the development of the Next Generation Science Standards (NGSS), states that:

First, [the Framework] is built on the notion of learning as a developmental progression. It is designed to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works. The goal is to guide their knowledge toward a more scientifically based and coherent view of the natural sciences and engineering, as well as the ways in which they are pursued and their results can be used.

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.

So, what does this look like in the classroom? The study of plants provides many examples of ways in which students build their understanding over time. Young students spend a lot of time exploring plants, soil, and water and love opportunities to plant seeds and watch them grow.

Beginning in first grade, students focus on seeds for an extended period of time. They explore their diverse characteristics, collect them, and set up seed windows in clear plastic cups to observe the germination and development of several varieties of seeds. They select one sprout to track by creating a simple bar graph, cutting a strip of paper to match the height of the shoot, and then repeating that process over several weeks to show the story of their plant’s development. They dissect a number of different fruits and create inside/outside collages, building toward an understanding that all fruits contain seeds. After learning about seed dispersal, they engage in seed engineering work, creating seed packages that can be carried as far as possible by the wind. Students are able to see many of these concepts in action as they work in the school garden. They also study honeybees and observe them as they gather nectar and pollen.

In the fifth grade, students revisit the topic of plants. Many of them will be able to refer back to earlier experiences in first grade, as well as more recent learning about photosynthesis and the vascular system of plants during the third- and fourth-grade tree study. As they engage in a detailed study of the structure and function of the parts of plants, each student plants and tracks the development of a set of Wisconsin Fast Plants, a rapid-cycling brassica that goes through its
entire life cycle, from seed to seed, in approximately seven weeks. Students are now able to track the growth of their plants in a more sophisticated way, creating a line graph to represent the growth rate of their set of plants, as well as a pictorial bar graph to capture changes in their plants’ structure over time. As students explore plant reproduction and the relationship between flowers and their pollinators, they create bee sticks and pollinate their own flowers to ensure a good crop of seeds. Through this work, they are able to recognize important connections between pollinators and our own food supply.

At the same time fifth-grade students are building on their earlier learning, they are exposed to new information and ideas that serve as a groundwork for learning in Middle School and beyond. For example, when students set up their Fast Plants experiments, they are directed to add N-P-K (fertilizer) pellets to their containers. Decoding this name leads to a brief exploration of the periodic table and a discussion of elements, a topic that will be revisited in greater depth over the next few years. As they prepare to create graphic novels to explain the process of photosynthesis, students use water and carbon dioxide models to create simple glucose molecules; for many, this is their first exposure to chemical equations.

In the same way that scientists build on earlier discoveries and learning to identify new areas for research, student scientists are continually building on their earlier experiences as they work to develop a more coherent and complex understanding of the way the world works.

The graphs below represent how data tracking and record keeping is scaffolded by grade. On the left, a first-grade student tracks plant growth visually. The photographs at center and right show a fifth-grade student using more complex methods to analyze plant growth for different species.
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