In order to support students in building these abilities across grade levels, teachers must explicitly discuss and support development of the crosscutting concepts and help students use the concepts as tools for analyzing new phenomena and questions they encounter.

Learning About the Structure of Matter in Elementary School: Grades K–2

At the lower elementary level, students observe and describe matter in different states (Mayer and Krajcik 2017). In the K–2 grade band, students are first introduced to CCCs, where an understanding of the CCC of patterns is needed to make sense of other CCCs. For example, the learning progression across grade bands for the CCC of cause and effect states that in the K–2 grade band, “students learn events have causes that generate observable patterns” (NGSS Lead States 2013b).

Classroom Snapshot 11.1 illustrates how a teacher helped students make sense of the concept of properties using the CCC of patterns. This two-day lesson was part of a larger
matter unit called “How Many Uses Can an Object Have?” in which students were learning about properties and the effects of heating and cooling on matter. In addition, the CCC was used to help students understand planning and carrying out investigations, specifically the importance of observations. Though not a focus of the lesson, there was also a discussion of why they sorted by one variable (property) at a time.

**CLASSROOM SNAPSHOT 11.1**

Exploring the Properties of Objects

Students were provided with two different objects and asked to write different words they would use to describe their objects (e.g., words about size, color, hardness). The teacher pointed out to the class the Observation Word Wall. Students were then asked to share out the words they used to describe their objects. She had different students share one of their words for each object and listed the words on the word wall.

The teacher then put the students in predetermined groups to sort their objects. The teacher purposefully provided objects that could obviously be grouped into different categories (i.e., by color, texture, size, hardness). She reminded the students that they were observing the different objects and could use their observation words from the word wall to describe their objects. The teacher then asked the student groups to put the objects into groups based on how similar they were. Students seemed confused about how to begin, so she initiated the following discussion to help them get started.

**Teacher:** “Who can give me an example of one way the objects are alike?”

**Student 1:** “Some are small; some are big.”

**Student 2 (from the same group):** “Some are rough and some are smooth.”

**Teacher:** “So, you both gave me two different ways the objects are the same. Class, in each of your groups, I want you to pick one way you can group your objects.” (The teacher addresses the group that shared.) “You can group your objects as small or big or as rough or smooth, but pick only one of those.”

The teacher then led a whole-class discussion to identify how different groups sorted their objects. The teacher selected a student from each group to explain how their objects were grouped. As the students shared their groupings, the teacher listed

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1. Dialogue is based on classroom observation notes and teacher reflection.

Continued
them on the whiteboard. Then the teacher held an explicit discussion on patterns with students. This discussion on patterns centered on why it is important to focus on one observation at a time (e.g., focusing on color versus focusing on color and size).

Teacher (pointing to groupings listed on board): “We have a lot of different groups here. How did you pick the way you would group your objects?”

Student 3: “We did red and white because we [saw] they were red and white.”

Teacher: “Another group chose colors, too—orange and blue. So we can group things by color.” (The teacher writes color on the board.) “Who had a different way they grouped their objects?”

Student 4: “We did bumpy and [smooth].”

Teacher: “How were you able to tell if the object was bumpy or smooth?”

Student 4: “I touched it, and that’s how it [felt].”

Teacher: “So you could touch it and you decided if it was bumpy or smooth. Scientists call how something feels texture.” (The teacher writes texture on the board next to bumpy/smooth).

The teacher continued the discussion to identify size and hardness as patterns. She then wrote the words size and hardness on the board, as well. Finally, she summed up the lesson.

Teacher: “So, you looked for ways that a lot of your objects were alike?”

Class: “Yes.”

Teacher: “Scientists look for how things are similar, as well. Like you, they use their senses to tell one object apart from another. They call this ‘looking for patterns.’ We have talked about different patterns today (points to color, texture, size and hardness written on the board). Tomorrow we will look at even more patterns.

On day two of the lesson, the teacher reviewed what they did the previous day to identify patterns. She then gave individual students different sets of objects and asked them to identify the patterns in their objects. The students identified their different groupings again. This time, the teacher pointed out the patterns they had grouped their objects by—color, hardness, texture, and size. The teacher then explained that scientists call these patterns “properties.”

Teacher: Scientists call these patterns properties. Properties are observations of an object that help to tell one object from another. Who can give me an example of a property?

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Student 5: “Color.”

In addition to learning about properties, students were able to further understand the practice of planning and carrying out investigations by focusing on observations. Discussions about the different groupings and words they chose to describe objects linked to the importance of their observations. It was important that they described their objects so they could sort the objects into different groups. In addition, it set the foundation for understanding variables (without using the term). In a discussion that arose about the reasons they sorted their objects the way they did, students talked about why they could only sort the objects by one property at a time. As the lesson progressed, students were given the opportunity to demonstrate their knowledge via their “own investigation” in which they were to individually sort a different set of objects using three different properties. They wrote down the different ways in which they sorted the objects. One student sorted objects by (1) color, (2) size, and (3) hardness and softness, whereas a different student sorted their objects by (1) color, (2) shape, and (3) size.

As a part of this unit, the CCC of patterns was explicitly discussed to help students understand what properties are. Students initially struggled with identifying the specific property they were using. After explicitly discussing the patterns they were employing, they were able to describe in everyday language what properties are. Once they were able to understand and identify different properties (e.g., hardness, size, color), they could define what a property is, using what they learned from their observations and discussions. Thus, students were able to develop their understanding of properties and deepen their understanding of investigations (an SEP) through the CCC of patterns.