Is It a Solid? Claim Cards and Argumentation

By Page Keeley

A Framework for K–12 Science Education’s disciplinary core idea PS1.A states that students should know by the end of grade 2 that different kinds of matter exist and many of them can be solid or liquid, depending on temperature (NRC 2012). By the end of grade 8, they describe solids, liquids, and gases by the arrangement and motion of their molecules. But what about “in between” ideas?

In the elementary grades, students are typically taught to define solids and liquids using macroscopic properties. Solids generally keep their shape and have a definite volume. Liquids have a definite volume but can take the shape of their container. Sometimes this definition is expanded to include that liquids can be poured. This definition using shape and pouring can be problematic when tiny parts of solid materials, such as powders or granules, are involved. In addition, the everyday use of the word solid implies something that is hard and not soft or “airy.”

The assessment probe, “Is It a Solid?” (Figure 1; Keeley, Eberle, and Dorsey 2008) can be used to elicit elementary students’ ideas about solids and the macroscopic properties they use to decide whether a material is a solid. It can reveal whether students have developed misinterpretations based on early definitions of solids and liquids and the familiar use of these words. Furthermore, when combined with the formative assessment strategy known as claim cards, the probe also provides insight into how elementary students engage in the scientific practice of argumentation.

Making Claims

Using claim cards involves printing each of the objects or materials that make up the answer choices onto separate cards. Each student is then given a card. Students sit in a circle, each holding a card. They begin with a whip-around the circle, each student sharing the item on their card and stating their claim as to whether they think their item is or is not a solid. After each student has shared his or her claim, the teacher asks for a volunteer to begin...
the science talk by restating his or her claim and justifying his or her thinking. She reminds the class of the norms for argumentation in science and that we respectfully argue in science to seek understanding, not win the argument. The following is a snapshot of the science talk that ensues in a fifth-grade classroom:

- Kara: “My claim is that wood is a solid. My evidence is that a block of wood keeps its shape, and if you measure the amount it stays the same.”
- Max: “But you can change its shape by cutting it.”
- Kara: “Yes, but whatever shape you cut it in, it holds that shape. It doesn’t spread out or anything.”
- Freddie: “Yeah, solids are hard, and wood is hard, so I agree with the claim.”
- Teacher: “Does anyone want to add to or disagree with Kara’s claim? Hearing no other ideas, let’s for now put wood under solid, on our claims chart. Who would like to go next?”
- Ivy: “I have flour. My claim is flour is not a solid. It is a liquid. First I thought it might be a solid because it isn’t wet like a liquid.”
- Teacher: “Ivy, you said it isn’t wet like a liquid, but you claim it is a liquid. Can you tell us why you think it is a liquid?”
- Ivy: “Well, it’s like what we learned about liquids. You can pour them out and when you put them in something, they fill the shape of the thing you put them in like water does when you put it in a cup. You can pour it and the water fills out the cup. So I think flour does the same thing.”
- Teacher: “Sharla, you want to add something?”
- Sharla: “I agree with Ivy. When me and my sisters make cookies, we pour the flour, and it’s not hard like wood is.”
- Teacher: “Who else has an idea to support or disagree with Ivy’s claim?”
- Hector: “I’m not sure. It’s kinda like water but not really, so I think it might be a solid.”
- Pete: “But it doesn’t keep the same shape like wood.”
- Teacher: “We seem to have two different ideas about flour—some of you think it is a solid, some think it is a liquid, and others are not sure. Let’s take a vote on where to put it on our claims chart. Remember, we will go back to our claims chart after our discussion, and you will have a chance to change your claims after you hear more arguments about whether the things on your…

Figure 1.
“Is It a Solid?” formative assessment probe.

Is It a Solid?

What types of things are solid forms of matter? Put an X next to the things on the list that are solids.

- ___ rock
- ___ rubber band
- ___ milk
- ___ feather
- ___ baby powder
- ___ sugar
- ___ foam-rubber ball
- ___ Styrofoam
- ___ air
- ___ flour
- ___ dust
- ___ cooking oil
- ___ sponge
- ___ iron nail
- ___ ice
- ___ wood
- ___ salt
- ___ melting wax
- ___ coal
- ___ cotton ball

Explain your thinking. What definition, rule, or reasoning did you use to decide whether something is a solid?
cards are solids or not solids.” Class vote indicates most think flour is a liquid, so the teacher lists flour under “not a solid” on the claims chart.

As each child shares his or her claim and justifies it with reasons for why it is or is not a solid, the teacher listens carefully for evidence of misconceptions or understanding about the properties of solids, liquids, and gases. She notes difficulties they seem to have with powders, soft materials like the cotton ball, stretchy things like the rubber band, and things that are light or airy like the sponge and dust. She realizes that part of the definition they used to describe liquids—anything that fills the shape of its container—is posing problems for the students when they consider powders or granular substances.

As she examines the Related Research summaries in the teacher notes that accompany the probe (Keeley, Eberle, and Dorsey 2008), she finds that her fifth-grade students’ ideas mirror the research on commonly held ideas students at that age may have. She realizes she has to design an experience using hand lenses for them to see that flour, baby powder, and sugar to see that these are really solids made up of a collection of individual solid pieces, and that some of these pieces can be very small. She also realizes she needs to give them multiple experiences to investigate solids that are soft and stretchy.

As the teacher reflects on the initial claims and argumentation session her students engaged in, she feels her students are really starting to grasp the practice of stating a claim and backing it up with evidence, even though their initial evidence may come from their naive conceptions about matter. By revisiting the claims chart after they have had opportunities to be confronted with their claims and work out some of the disparities on the claims chart, she will be able to formatively assess the extent to which they can now draw upon evidence from their investigations and further research into characteristics of solids, liquids, and gases as they engage in argumentation.

This example shows how you can use formative assessment to uncover and—through carefully designed instruction—confront students’ ideas about the macroscopic properties of solids before they move onto microscopic properties in middle school. Simultaneously, it provides an informal assessment window into students’ ability to state claims and engage in argumentation. Ready-Set-Science states that “In spite of the importance of talk and argument in science and in the learning process in general, K–8 science classrooms are typically not rich with opportunities for students to engage in these more productive forms of communication” (Michaels, Shouse, and Schweingruber 2008, p. 89). There are many examples of assessment probes in the Uncovering Student Ideas in Science series you can use with the claim cards strategy to support the scientific practice of argumentation while developing deeper understanding of disciplinary core ideas.

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References