Introduction

The Interactions unit as a whole is designed to supports high school students in using three-dimensional learning to make sense of phenomena and solve problems by evaluating their own ideas. Students conduct investigations, collect evidence, and use the evidence to evaluate claims. In response, the teacher's role shifts away from providing information and toward guiding students as they learn to use evidence to support and their ideas about the phenomenon or problem. The curriculum is designed to give teachers frequent insight into their students' progress so they have the information they need to provide this guidance.

Here, we discuss one activity from Investigation 3 in Unit 1. The four activities in Investigation 3 are all tied to the driving question: *What are all materials made of?* In Activity 2, examined here, students observe a surprising phenomenon when they make three combinations of substances. When they combine water with water and ethanol with ethanol, the substances increase in volume by a predictable amount. But when they combine ethanol with water, the volume increase is smaller than expected. Students develop, evaluate, and refine a model to explain this phenomenon.

STANDARDS:

This task is embedded as part of an instructional sequence building toward the NGSS PE:

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

ANNOTATION KEY

EQUITY
Supporting a wide range of diverse students.

SCENARIOS
Information provided to elicit performances.

SEPs
Opportunities to demonstrate science and engineering practices.

DCIs
Opportunities to demonstrate understanding of disciplinary core ideas.

CCCs
Opportunities to demonstrate understanding of crosscutting concepts.

SENSE-MAKING
Opportunities for reasoning about phenomena and problems.

ASSESSMENT PURPOSE
Highlights how the task features connect to intended assessment use.

✓ STRENGTHS

This task **exemplifies authentic use of the three dimensions in the service of sense-making about the phenomenon**. Students draw on all three dimensions *as they are needed* to understand and explain the phenomenon.

Students **use many different elements of the SEP** through writing, drawing, and discussion, and in each case the elements work together to deepen students' understanding of the science ideas.

The task u**ses SEPs for revealing students' progress** with the DCI and SEP to the teacher, as well as a self-assessment tool for students to reflect on their own growing understanding.

The t**eachers' materials offer critical attention to learning goals and how to draw formative information about students' progress** from the task, including suggestions about how to address areas of need as revealed by students' responses to prompts.

The g**uidance for teachers attends to all 3 dimensions** (in different questions), reinforcing the importance of supporting students' progress across the dimensions and that the assessments are not punitive, they are about gathering evidence of how to support student learning.

! OPPORTUNITIES FOR IMPROVEMENT

It is **not clear how explaining this phenomenon is important or significant** beyond this experiment in the lab.

While the inclusion of guidance for how teachers can use embedded assessments to address areas of need is promising, in many cases (not all) the **guidance that is offered is not particularly instructive**.

Students **do not use the ideas they have figured out to explain the full phenomenon** they noted at the beginning of the task. They explain why the mixture could have a different volume than predicted, but they don't explain why the water mixed with water *did* have the predicted volume but the water mixed with ethanol *didn't*.

The **DCI, SEP, and CCC that are cited as the learning goals of the activity are only addressed in part**, but the parts that are addressed were those needed to make sense of the phenomenon.

How does this task support all students?

✓ The task supports all students by incorporating frequent checks on students' progress through modeling, pair and group discussion, and written responses. These frequent checks allow teachers to elicit evidence of where students are. Use of multiple-choice items to diagnose student ideas offers useful attention to students who might be struggling. Suggestions for ways teachers can use the multiple-choice items to inform instructional decisions help point teachers to these needs and ways to move all students toward the learning goals throughout the course of the activity.

Through the use of multiple representations of the phenomenon from an investigation, interactive visualization, demo, and students' own models, students have many ways to access the phenomenon and the science concepts behind it. Students also have many opportunities to reflect, revise and re-think their ideas after discussing them and considering other students' ideas.

What are the major takeaways?

SUMMARY POINTS:

This task is a valuable model of authentic use of the three dimensions in the service of sense-making about a simple, accessible phenomenon. Students evaluate and modify their models in service of deepening their understanding of the phenomenon. There are many places where students are providing evidence of their progress in just one dimension, but this is reasonable as they are formative diagnostic probes that are scaffolding students' progress toward the culminating tasks where students evaluate their own initial models and discuss and compare how well different models represent the phenomenon. The task is also valuable as an example of how instructional materials can support teachers in using embedded assessments to ensure that all students are progressing with all of the dimensions.

This task provides a nice example of how SEPs can be used for different purposes--skills, representing student ideas, and sense-making--appropriately throughout the task.

SUGGESTED IMPROVEMENTS

The materials would be strengthened by:

- helping students make a connection between the lab-based phenomenon and one of broader relevance,
- by providing even more substantive guidance about attending to students' specific needs based on their responses to the prompts, and
- by ensuring that the students' sense-making requires the CCC to be a more explicit aspect of their demonstrated performance (note that this may indeed occur in later activities).

How should this task be used?

It is most useful as a curriculum embedded assessment since it is designed to provide frequent formative information about students' progress; it provides frequent checks on the development of students' ideas and their ability to refine their model to incorporate their growing understanding of the phenomenon. These embedded assessments can be used to ensure that all students are progressing with the three dimensions, and as quick diagnostics to identify where they are struggling. Even though the task only assess parts of the dimensions it sets out to address, the parts it does assess are those necessary for the task. It would be helpful if the teacher materials were explicit about which parts of each dimension it is addressing.

This can also be useful as a model for how other curriculum-embedded tasks can be used as effective opportunities to surface student understanding and ability to use the three dimensions in various and appropriate ways.