ABSTRACT: This study examines the ways in which teachers provide students with written scaffolds in assessment tasks and the impact of these on students’ abilities to demonstrate a core disciplinary proficiency—constructing evidence-based explanations. Data include 76 assessment tasks designed by 33 science teachers and 707 samples of student work. We found five types of scaffolding embedded in assessments that allowed students to make their reasoning explicit: (a) using contextualized phenomena, (b) rubrics, (c) checklists, (d) sentence frames, and (e) encouraging students to draw explanatory models in combination with written explanation. Analyses showed that all five forms of scaffolding were significantly associated with the quality of student explanation even when controlling for teacher variance and student background. Providing contextualized phenomena had the greatest impact on the quality of student explanations, both by itself and in combination with other scaffolding. The results indicate that strategic combinations of scaffolds can prompt students across all achievement levels to more readily use what they know to produce evidence-based explanations, but that the scaffolding must be of high quality.


Scaffolding by Contextualizing a Focal Phenomenon (p.10)

There was substantial difference in both the nature of explanation and the ways in which focal phenomena for explanation were framed in assessments. One group of assessment tasks asked students to explain general phenomena, “Why do siblings look different?,“ “Why is the equator hotter than the poles?,“ and “Why do the seasons change?” Often these assessments asked students to explain scientific ideas rather than an observable event, such as “What is homeostasis and why is it important to our body?” Representations of those events or phenomena usually appeared in the textbook. In contrast, some teachers contextualized a phenomenon or event in a particular time, place, and situation. For example, instead of asking about generic seasonal changes, one teacher asked, “Why don’t countries near the equator, like Samoa, seem to have seasons like we do here in Seattle?” In another assessment in a unit on force and motion for the seventh grade, a teacher contextualized the physics in the form of “the skater girl”—a young woman in a local community where the school is located (see Figure 3):

A skater girl is flying down the big hill on 102nd (right in front of Steve Cox Memorial Park, where that cabin is, behind McLendon’s Hardware) when she realizes that some jerk has built a huge brick wall across the road. She knows that she won’t be able to stop in time. What should she do to minimize, or decrease, her injuries? Explain why this is the best option for the skater girl.
Contextualized Phenomena: 
Making the Task Intellectually Challenging But Accessible. (p. 25)

We hypothesize that contextualization helps students engage in deeper forms of reasoning and demonstrate in-depth explanations in four ways. First, contextualization problematizes a generic set of conditions. For example, in the assessment about the sea- sons, contextualizing the generic phenomena of seasonal changes in two different geo- graphic regions (i.e., Samoa and Seattle) generates multiple variables that must be taken into account, such as relative distances of different parts of the earth from the sun (neg- ligible), changes in the angles of the sunlight on the earth, penetration of light through layers of the atmosphere, etc. This contextualization prompts students to recognize the general model of seasonal change and then reason how this model plays out under different conditions. Second, a contextualized phenomenon supports students in moving beyond reproductions of textbook explanations about general phenomena. The fact that there is no authoritative “answer” from a textbook helps a teacher and students reposition themselves as coinvestigators in the process of actually making sense of the phenomena. Third, situating the phenomena in the everyday experiences of students and their families helps them draw in additional intellectual resources from observations and relevant accounts of others (Nordine, Krajcik, & Fortus, 2010; Shwartz, Weizman, Fortus, Krajcik, & Reiser, 2008).

For example, in the skater girl assessment (see Figure 3), students used scientific ideas, such as momentum, friction, and acceleration, but also drew upon their everyday reasoning re- sources, such as “she shouldn’t drag her feet/bottom because of the friction from the coarse cement would hurt her” or “When you roll on the floor there is friction so it slows you down if you have a lot of ways.” In this way, students drew on prior experiences and observations about slowing down as their bodies interacted with different surfaces and made sense of science ideas simultaneously. Finally, contextualizing a phenomenon in a particular local community helps students relate to the problem, which allows them to become engaged in the work actively and emotionally. Walqui (2006) describes the importance of “bridging” as establishing a personal link between the students and the subject matter by showing the relevance of new materials to the students’ life “here and now” (p. 172). The problems that produced richer student explanations—richer meaning longer, more detail, and support for a claim—tended to describe an event/phenomenon that was relevant to the students’ everyday life, such as the skater girl’s story. In short, contextualized phenomena makes the task more cognitively challenging by problematizing a generic set of conditions and by inviting students to engage in complex reasoning, but at the same time its situatedness in a set of recognizable conditions makes the task more accessible to students.
Final Explanation: The Skater Girl

THE SITUATION: A skater girl is flying down the big hill on 102nd (right in front of Steve Cox Memorial Park, where that cabin is, behind McLendon’s Hardware) when she realizes that some jerk has built a huge brick wall across the road. She knows that she won’t be able to stop in time. What should she do to minimize, or decrease, her injuries?

FINAL EXPLANATION: Use your journal, the Word Wall, and your Evidence Buckets to answer Questions 1 – 3.

1. What should the skater girl do to minimize her injuries? (1 point) __________

2. Explain, using words and pictures, why this is the best option for the skater girl. Use as many words from the word wall as you can. Use the space below to draw a picture that helps you answer if you need it. (3 points)

Word Bank

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Vector</th>
<th>Acceleration</th>
<th>Momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force</td>
<td>Net force</td>
<td>Friction</td>
<td>Mass</td>
</tr>
</tbody>
</table>

- 1 point: Describe the forces acting on the skater girl in #1.
- 1 point: Use at least 3 words from the Word Bank/Word Wall.
- 1 point: Explain why this is better than another choice she has.
- 1 point: Draw a picture that helps explain your answer.

The skater girl should try to
(____) steer towards the grass, pond, or other surface to avoid
the wall because steering
(____) away would result in
her accelerating in such a way that
her velocity decreases & force
won’t impact her as greatly.
It would be when hitting the wall
because the sudden change in
momentum would hurt her, & she
shouldn’t drag her feet butt
because of the friction from the
coarse cement would hurt her.
She would still hit the wall.

USING EVIDENCE: Use your Evidence Bucket to answer this question.

3. Give at least one piece of evidence from a class activity that supports your ideas in #2. (2 points)

The egg video thing shows that when momentum
is changed very slowly, the stopping force upon said
body is also very low. However, if momentum
is changed abruptly, the stopping force is very high.
Therefore, we know it would be a good idea for the girl
to slowly change her momentum, so that her stopping force
is small & injuries acquired are also fairly minor.

Figure 3. Force and motion assessment: What should the skater girl do to minimize her injuries?