Prompts for Integrating Crosscutting Concepts Into Assessment and Instruction

The new vision for science education features a three dimensional view of learning that involves: science and engineering practices, crosscutting concepts, and disciplinary core ideas. Many educators already incorporate crosscutting concepts into their teaching, but may still be looking for ways to amplify these concepts or to make them more explicit for their students, including in their classroom assessments.

This set of prompts is intended to help teachers elicit student understanding of crosscutting concepts in the context of investigating phenomena or solving problems.

These prompts can be used as part of a multi-component assessment tasks—or they can be used in formative assessment discussions in the classroom. These prompts should not be used in isolation, and the blanks provided are intended to be determined using the content of the scenario presented at the beginning of a multi-component task. The prompts can be open-ended, as shown below. They can also be turned into multiple-choice questions. These prompts were developed using A Framework for K-12 Science Education and Appendix G of the Next Generation Science Standards, along with relevant educational research.

These prompts have not yet been tested or evaluated in the field. However, educators and researchers are welcome to use them. We request you send feedback and information about how you have used the prompt to william dot penuel at colorado dot edu.

Our team has also created a similar tool to help educators create tasks that incorporate the science and engineering practices into their teaching, found at stemteachingtools.org/brief/30. You can learn how to develop 3D formative assessments here: http://tinyurl.com/3Dassessmentdevelopment

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Crosscutting Concept: Cause and Effect

***A Framework for K-12 Science Education* description of cause and effect**: Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

When drawing conclusions from a simple investigation, ask students:

- What caused the patterns you observed?
- Follow up question: How do you know that ________ caused ________ ?
- Does the fact that that the data showed that ________ always happened [after/whenever] occurred mean that ________ causes ________ ? Why or why not?
- Follow up question: How can you test whether ________ caused ________ to happen?
- What do you predict would happen if [extrapolate to new, related situation]?

*When seeking to elicit whether students understand the **underlying mechanism** involving something that is not part of the surface situation presented in the scenario, ask students:*

- What [properties, entities, or rules] that aren't described explain what you see happening [in the scenario]?
- What would you predict in [present new situation involving same mechanism] would happen? How is the situation similar to or different from [the presented scenario]?

*When a system or situation presented in the scenario involves **complex or relational causality** (e.g., as in ecosystems and co-evolution), ask students:*

- Draw a diagram that shows how changes to one component of the system affects components that are not directly connected to that component.
- What do you predict would happen if [change to one component of complex system] to [component that has an indirect, rather than direct, connection to the first component]?
- How do ________ and ________ affect ________?
- How do ________ and ________ affect each other over time?
- What feedback loops are causing this system to be in [balance/equilibrium]?
- How can a small change to ________ have a big effect on ________?

*When the system or situation involves **probabilistic but not deterministic causality**, ask students:*

- Does knowing [the level or value of cause] allow you to predict [the level or value of effect] with certainty? Why or why not?

*When seeking to elicit students' skill in **evaluating causal claims**, ask students:*

- Is [claim that states a causal relationship or a claim that states a correlational relationship] a causal claim? If so, what makes it a causal claim? If not, why not?

- What evidence presented in the scenario supports the claim that ________ causes ________?
- Can the study design provide evidence as to whether ________ causes ________? Explain why or why not.
- Is the evidence presented sufficient to conclude that ________ caused ________? If not, what additional evidence is needed?

When analyzing ***causes of failure in a designed system****, ask students:*

- Draw a diagram of the system, showing what is causing the pattern of failure observed in the test of the system.
- Design a test to figure out what is causing the failure of the system, given the data presented.