STEM TEACHING TOOL #41

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 should be used as part of a multi-component extended task. They should not be used in isolation, and the blanks provided are intended to be filled using the content of the scenario presented at the beginning of the 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 the Framework for K-12 Science Education and Appendix G of the Next Generation Science Standards, along with relevant learning sciences research.

These prompts are currently being tested or evaluated in the field. We request you send feedback and information about how you have used the prompt to william dot penuel at colorado dot edu.

Please note that some prompts may not be suitable for students in early grades, while others may be low-level for high school students. Designers should consult the learning progressions in Appendix G of the NGSS to choose a prompt that is appropriate for different grade level bands.

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: Energy and Matter: Flows, Cycles and Conservation

A Framework for K-12 Science Education description of **energy and matter:** Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

When making observations of simple systems where materials are broken apart or reassembled:

- What happens to _____ when you put it together with _____?
- Is there more, less, or the same of _____ when you combine it with _____?
- What kinds of material is [assembled object] made of?

When eliciting understanding of how energy transfers drive the cycling of matter within and between systems:

- How does the flow of energy between _____ and _____ drive the cycling of matter in the ___ system?
- How does the flow of energy between _____ and _____ drive the cycling of matter between _____ and _____?

When eliciting understanding of the cycling of matter, ask students: (Scale: The movement question can be answered at the atomic-molecular, cellular, or macroscopic scale.)

- Where is matter coming from that enters [this system]?
- What happens to matter as it moves within [this system]?
- Where does matter go that leaves [this system]?
- Draw a picture showing the the stocks and flows of matter in [this system].
- Where are the molecules moving in [this system]?
- What evidence is there that matter is conserved in this cycle?

When eliciting understanding of changes to matter, ask students: (Scale: The chemical change question is always answered at the atomic-molecular scale.)

- How are atoms in molecules being rearranged into different molecules?
- What molecules are carbon atoms in before and after the chemical change?
- What substance are the carbon atoms part of before and after the chemical change?
- What other molecules are involved?
- What evidence is there that matter is conserved in these changes?

When eliciting understanding of energy change, ask students: (Scale: These energy questions can be answered at the atomic-molecular, cellular, or macroscopic scales.)

- How is energy coming into this system?
- How is energy going out of this system?
- What forms of energy are involved in this system?
- What energy transformations take place during the chemical change?
- How much energy is needed to [make something happen]?
- What energy is entering, staying, and leaving [the system]?
- Draw a picture showing the stocks and flows of matter in [this system].
- Where does the _____ get its energy?
- What evidence is there that energy is being conserved in this system?