STEM TEACHING TOOL #91

Why and how should I use crosscutting concepts to enhance my science instruction?

What Is The Issue?

In the NRC *Framework* vision for science education, the crosscutting concepts (CCCs) are a key component of three-dimensional learning, yet many educators and educational leaders remain unclear about their use in science instruction. The CCCs include: patterns; systems and system models; cause and effect; scale, proportion, and quantity; energy and matter; structure and function; stability and change. The CCCs are thinking tools that have applications across the sciences (and into other disciplines). Clarity on their instructional use is essential as the CCCs promote integrated understanding and are necessary for a coherent and scientifically based understanding of the universe.

WHY IT MATTERS TO YOU

- **Teachers** should support students using the CCCs to make sense of phenomena and solve problems while using them to identify strengths in students' thinking.
- **District Staff & PD Providers** should model integrated use of CCCs during professional learning when supporting sensemaking of disciplinary core ideas (DCIs) by engaging in the science and engineering practices (SEPs).
- **School Leaders** should provide teachers opportunities to explore how CCCs support sensemaking (e.g., collaboratively review students' work or videos) and join in classroom discussions to observe their use.

Things To Consider

- There are many ways to support students learning using CCCs. Using the CCCs to make sense of DCIs can help illuminate new factors that influence systems or processes. For example, using CCCs to engage in SEPs can help us to identify patterns in data or define the components of our model (Fick & Arias, 2022).
- When we teach science using a practice-based approach (i.e., supporting sensemaking of phenomena by engaging students in the science and engineering practices), CCCs are an implicit tool that we use as a part of that process (Fick et al., 2021). STEM Teaching Tool #41 provides ways that CCCs can be brought into a lesson in an integrated way; however, there still needs to be a common language that helps highlight the use of CCCs. Providing explicit (e.g., verbal, written) identification of CCC use can support students in seeing how these thinking tools are useful for scientific sensemaking.
- Students bring culturally related strengths to learning about science, and we are only beginning to understand what those might look like in the context of CCCs (e.g., Cheek, 2017). Therefore, approaching students' sensemaking with interest, wonder, and curiosity has the potential for creating the most expansive and inclusive approach to science learning (see consensus research report). CCCs should be thought of as part of the diverse sensemaking repertoires of students.

Recommended Actions You Can Take

- **Use CCCs both explicitly and implicitly.** When teaching science and gathering students' thinking throughout your unit, highlight connections across different DCIs. Try to use consistent language when modeling your thinking: "In the context that we're working in, what do you think counts as a pattern?"
- **You can encourage students to use the CCCs for sense-making and examine how students can use different CCCs to interpret their ideas differently.** For example, is a student using an unanticipated CCC to explain this phenomenon? What are the benefits and challenges of that approach? However, CCCs should *not* be assessed individually and should always connect with SEPs and DCIs. While challenging, consider developing 3D assessment tasks using this short course and PD module.
- **Establish routines for students to use the CCCs.** Amid productive uncertainty, suggest students use the CCCs to connect "what you know" to "what you're figuring out." Have students use CCCs to deepen their engagement in the SEPs. Depending on the topic, some CCCs might be more valuable than others. We should support diverse sensemaking in our classrooms and consider the strengths of different approaches.
- **Study high-quality examples of CCC use.** This NSTA book (see sample chapters) harnesses the work of dozens of experts who explain each CCC in detail and provide examples of classroom use. See also these webinars.

REFLECTION QUESTIONS

- How and when can I make use of the CCCs to frame scientific ideas and explanations in our classroom and make them more understandable to students?
- Do my lessons and instruction highlight the CCCs as an integrated component with the DCIs and SEPs? Are there additional CCCs that could improve a lesson or unit?
- How can I honor and support students' use of the CCCs related to culturally based / community knowledge?

Attending to Equity

- **Engaging students' scientific funds of knowledge.** The crosscutting concepts act to leverage resources students have to help them understand new and different ideas. This helps to engage the prior knowledge and resources typically underutilized in traditional school instruction. The CCCs encourage students to bring in more of their ideas, resources, and connections.
- **Promoting agency and coherence across contexts.** Teachers build more coherence and unity between individual units and lessons by encouraging students to engage with and discuss CCCs in every unit. While teachers should make space for these discussions, it is crucial students connect these ideas themselves. Students' knowledge building should be encouraged and celebrated.

ALSO SEE STEM TEACHING TOOLS:

#60 Productive Uncertainty
#41 CCC and Assessment
#75 CCC as Tools for Reflection

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