Empowering Teachers to See and Support Student Use of Crosscutting Concepts in the Life Sciences

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Background & Context

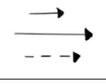
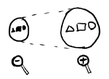
The Next Generation Science Standards elevated crosscutting concepts (CCCs) to stand as a dimension within the learning process that requires explicit attention. How teachers use the CCCs within their classrooms is only beginning to be understood. A review of the literature shows there are four potential ways that the CCCs may be used: (1) connected to Disciplinary Core Ideas, (2) as a part of engaging in Science and Engineering Practices (SEPs), (3) as a means of connecting across disciplines, and (4) something that students learn culturally that can be an asset for science learning.

Project Goals

In this project, we are developing strengths-based formative assessment tools to support students' use of the crosscutting concepts in phenomenon-based science learning. We have used the SEP of *Developing and Using Models* as a window into student use of the CCCs, co-developing instructional supports with participating teachers. We are now connecting these supports to aspects of the formative assessment process (e.g., visualizing success, eliciting evidence of student thinking, providing feedback, and cultivating student self-assessment).

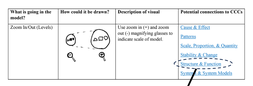
Visual Library of Modeling Elements

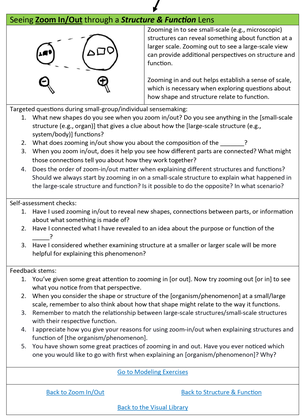
Our partner teachers identified the SEP of *Developing and Using Models* as a relevant sensemaking practice in their phenomenon-based instruction to connect to use of the CCCs. After periodic discussions with teachers of students' successes and struggles, we identified a need to help students translate their thinking into the visual form of their modeling tasks. We co-conceived with teachers the idea of a visual library to address this need. The visual library identifies potential model components and offers simple visual depictions along with a brief rationale or description for each depiction. Teachers can customize the visual library by 1) selecting which modeling components to display or allowing students to generate a list of components, 2) providing visual depictions and descriptions or allowing students to create their own. Thus, teachers have the power to scaffold the development and use models as they deem appropriate for students at a particular point in the course.

What is going in the model?	How could it be drawn?	Description
Flow of Energy		Directional movement of energy (light, heat, etc.) Squiggly to differentiate flow of energy from flow of matter or motion arrow
Movement/Motion		Arrows to/from whatever is in motion (like a water molecule in motion); Lines behind object to indicate direction of movement (can use the length of the line to indicate speed—long for fast, short for slow)
Zoom In/Out (Levels)		Use zoom in (+) and zoom out (-) magnifying glasses to indicate scale of model.
Biomolecules: Carbohydrates		

Connecting to the Crosscutting Concepts

Our observations of teacher practices and student work samples suggested a need to focus on more instructionally embedded aspects of formative assessment, such as probing to elicit student thinking, providing feedback on student work, and enabling student self-assessment. From the foundation of the visual library, we identified salient connections between modeling components and CCCs (e.g., using a Zoom in/out depiction to demonstrate thinking about structure and function). For each intersection between modeling component and CCC, we are developing a one-page guide of formative assessment prompts (left). When teachers would like to see these intersections within the context of subject matter, we are developing vignettes of hypothetical classroom phenomenon-based modeling and teacher use of the formative assessment supports (middle, [excerpt]). Modeling exercise snapshots provide another, briefer illustration of connections between modeling components and CCCs, embedded within content (right).





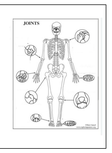
Mrs. Hernandez teaches Biology at a small rural High School in the state of Washington. Since the adoption of the NGSS Mrs. Hernandez has been working hard to redesign her lessons to align with a 3-Dimensional Science framework. Today she is planning on having her students to begin exploring the following standard:

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Her students have just finished a lesson about how cells perform life functions and now will begin a lesson focusing on differences between the structure and function of cells to inform students' understanding of hierarchical tissue organization.

Using everyday household objects, have students think of ways they can improve on the object and create models illustrating the initial and improved designs. Using the Zoom in/out tool, have students indicate where design changes and related changes in functions were made. You can give students a selection to choose from, or students can come up with their own. You can determine the level of complexity or constraints.

Provide students with blank templates of animal, plants, or human structures, zoom-in and choose specific structures, and have students infer the function of those structures based on their prior knowledge. You can determine the level of complexity and ask additional questions for students to provide explanations or for critical thinking regarding structure and function. An example template of skeletal joints with zoom-ins is pictured to the right.



Next Steps

- Package supports within a dynamic web-based interface along with:
  - Implementation guidance
  - Topical primers (e.g., formative assessment, task framing)
  - Connections to teacher eval. frameworks
- Engage teachers and students in cognitive interviews to refine design and further learn about conceptions of modeling and CCCs
- Professional learning via implementation
  - One-year PLC schedule
  - Focus #1: Teacher development in planning and practice that meets NGSS elevation of the CCCs and empowering potential of formative assessment
  - Focus #2: Student development in use of the CCCs

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