

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.


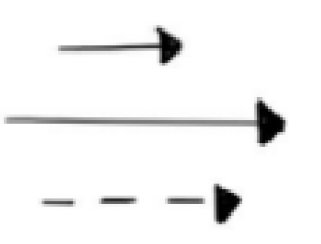
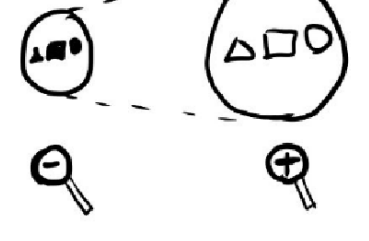
Project Goals

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.

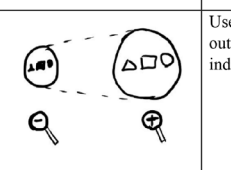
What is going in the model?	How could it be drawn?	Description
Flow of Energy		Directional movement of energy (light, heat, etc.) Squiggly to differentiate flow of energy from flow of matter or motion arrow
Movement/Motion		Arrows to/from whatever is in motion (like a water molecule in motion); Lines 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		

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

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).

What is going in the model?	How could it be drawn?	Description of model	Potential connections to CCCs
Zoom In/Out (Levels)		The zoom in (+) and zoom out (-) magnifying glasses to indicate scale of model.	Scale & Proportion Systems & Models Structure & Function Stability & Change Energy & Matter

Seeing Zoom In/Out through a Structure & Function Lens

Zooming in to see small scale (e.g., microscopic) structures can reveal something about function at a larger scale. Zooming out to see a large-scale view can provide additional perspectives on structure and function.

Zooming in and out helps establish a sense of scale, which is necessary when exploring questions about how shape and structure relate to function.

Targeted questions during small-group/individual sensemaking:

- What new shapes do you see when you zoom in/out? Do you see anything in the [small-scale structure (e.g., organ)] that gives a clue about how the [large-scale structure (e.g., system/body)] functions?
- What does zooming in/out show you about the composition of the _____?
- When you zoom in/out, does it help you see how different parts are connected? What might those connections tell you about how they work together?
- Does the order of zoom-in/out matter when exploring different structures and functions? Should we always start by zooming in on a small-scale structure to explain what happened in the large-scale structure and function? Is it possible to do the opposite? In what scenario?

Self-assessment checks:

- Have I used zooming in/out to reveal new shapes, connections between parts, or information about what something is made of?
- Have I connected what I have revealed to an idea about the purpose or function of the _____?
- Have I considered whether examining structure at a smaller or larger scale will be more helpful for explaining this phenomenon?

Feedback stems:

- You've given some great attention to zooming in [or out]. Now try zooming out [or in] to see what you notice from that perspective.
- When you consider the shape or structure of the [organism/phenomenon] at a small/large scale, remember to also think about how that shape might relate to the way it functions.
- Remember to match the relationships between large-scale structures/small-scale structures with their respective function.
- I appreciate how you give your reasons for using zoom-in/out when explaining structures and function of the [organism/phenomenon].
- You have shown some great practices of zooming in and out. Have you ever noticed which one you would like to go with first when explaining an [organism/phenomenon]? Why?

[Go to Modeling Exercises](#)
[Back to Zoom In/Out](#) [Back to Structure & Function](#)
[Back to the Visual Library](#)

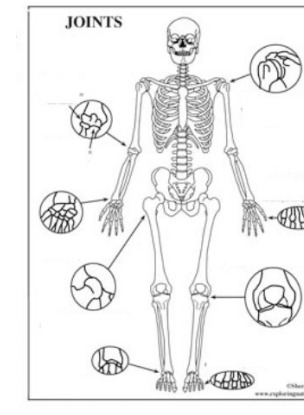
Mrs. Hernandez teaches Biology at a small rural High School in the state of Washington. Since the adoption of the NGSS Mrs. Hernandez has been working hard to redesign her lessons to align with a 3-Dimensional Science framework. Today she is planning on having her students to begin exploring the following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



Acknowledgments

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