Scaling a System of Professional Learning for Formative Assessment Co-Design: The Aspire Project

Erin Marie Furtak, Clarissa Deverel-Rico, Jason Y. Buell, Kate Henson, and Kelsey Tayne
erin.furtak@colorado.edu, clarissa.deverelrico@colorado.edu, jason.buell@colorado.edu,
kate.henson@colorado.edu, kelsey.tayne@colorado.edu
University of Colorado Boulder

Abstract: We have scaled an approach to support science teacher professional learning around classroom assessment using a learning progression and associated tools and routines to support student modeling of the crosscutting concept of energy. We describe the design of the learning progression and the ways in which it allowed us to scale science classroom assessment co-design across high school physics, chemistry, and biology professional learning communities.

Introduction

The *Framework for K-12 Science Education* (National Research Council [NRC], 2012) established a new vision for science learning where students engage in scientific practices and apply crosscutting concepts as they learn disciplinary core ideas in order to develop explanations of novel phenomena in the world around them. Creating assessments consistent with this vision has been difficult to achieve, along with supporting teachers to understand, develop, and use those assessments to inform classroom practice. School districts need coordinated systems to realize the potential of *Framework*-aligned assessments that inform classroom instruction (Penuel, 2019).

We have developed a professional learning system with the intention of transforming science teaching and learning based on a crosscutting concept, defined as concepts that unify the sciences (e.g. cause and effect, patterns, matter and energy flows in systems). This system has been developed as part of a larger Design-Based Implementation Research project conducted in partnership with a large school district (Penuel et al., 2011) between district-based curriculum specialists and researchers at the University of Colorado Boulder. In this poster, we describe (1) the learning progression that is the foundation of the professional learning system, (2) the affordances of that learning progression in scaling a professional development approach for high school physics, chemistry, and biology teachers, and (3) the tools and routines for supporting formative assessment co-design.

Building learning progressions for modeling energy flows in systems

Learning progressions are representations of the empirically grounded and testable hypotheses about how students' understanding within a subject domain becomes more sophisticated over time (Corcoran, Mosher, & Rogat, 2009). Our learning progression (Buell et al., 2019) traces the ways students can create increasingly sophisticated models (Pierson et al., 2017; Schwarz et al., 2009) of phenomena related to energy flows within systems (Neumann et al., 2013; Park & Liu, 2012). This progression then served as the center point to create performance expectation (PE)-specific three-dimensional learning progressions consisting of a scientific practice (in this case, modeling); a crosscutting concept (energy) and a disciplinary core idea (Figure 1).

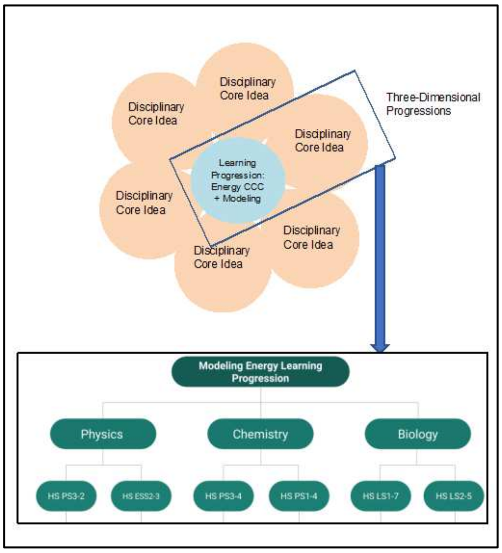

Figure 1. Scaling approach to produce three-dimensional learning progressions for HS physics, chemistry and biology.

Scaling professional learning approach

We then used these three-dimensional progressions as the foundation for the co-design of classroom assessments in discipline-specific professional learning community meetings with high school physics, chemistry, and biology teachers (see Figure 2 for an example). University-based researchers and district science coaches then engaged teachers in routines around these PE-specific learning progressions to explore student thinking about energy, co-design assessment tasks, enact those assessments in their classrooms, and then identify next steps for instruction. These routines were supported with a suite of tools including common templates for modeling tasks, assessment quality checklists, and processes for using the learning progression to analyze samples of student work. In the 2018-2019 academic year, we facilitated over 100 on-site meetings with teachers and supported iterative cycles of formative assessment design in high school physics, chemistry, and biology units focused on energy, ultimately designing nine new tasks with teachers to engage students in three-dimensional science learning experiences.

Level	A Learning Progression for Modeling Energy Flows	Look fors for PS 3-4
5	☐ Students are able to generalize their model to unknown or multiple phenomena, and can explain limitations of applying the model to a new phenomenon.	○ Multiple phenomena OR ○ Limitations to generalization in scope or intensity
4	☐ Students develop a model that illustrates a mechanism that can explain or predict the phenomenon, AND use the model to make predictions about how changing one part of the model would influence energy flows elsewhere in the system. ☐ Students can explain how the total energy of the system constrains the magnitude of change possible. ☐ Students can describe limitations of the model in explaining or predicting the phenomenon	○ Multiple scales within model (zoom-in) showing molecular motion including speed and direction. ○ Quantitative change in temperature, formulas or graphs. ○ That temperature becomes more uniform but total energy does not increase. ○ Identify a possible change in phenomenon and what model predicts would happen
3	☐ Students use or develop a model that relates changes in the phenomenon directly to changes in energy through transfers/transformations by identifying specific indicators. ☐ Students begin to show evidence that their model is accounting for conservation and dissipation. ☐ Model includes energy flows into, within, and out of the system.	○ Changing relative temperature of systems and surroundings or between different objects. Every temperature increase should also have a temperature decrease somewhere else. ○ Explicit links between changing temperatures and energy transfers shown.
2	☐ Students use or develop a model to illustrate a relationship or pattern between the increase in one form of energy and the decrease in another form, or transferred from one location or object to another. ☐ Students identify the most relevant components and relationships in the model and distinguish between the system and surroundings ☐ Model focuses on energy flows within the system only.	○ Correctly labeled arrows showing conduction or convection (transfers). ○ Arrows indicating net flow of thermal energy from one object to another or between system and surroundings. ○ Circle or label to indicate system and surroundings.
1	☐ Students use or develop a model that shows, through drawings or labels, the components involved in a phenomenon, some (but not necessarily all relevant) energy forms, transfers, or transformations.	○ Literal components ○ Some energy forms labeled ○ Energy transfers may not start or end in an object

Figure 2. Sample learning progression with PE-specific “look-fors”.

Significance

This poster presents a key affordance of the crosscutting concepts: how following one concept into different grade bands can create the foundation for a scalable professional learning approach that is not only discipline-specific, but also supports students in related trajectories of learning across grade bands. In the poster, we share vignettes of teachers engaging in co-design routines in professional learning communities, examples of the co-designed assessments developed with the learning progression, and the tools we used to support those routines as we sought to improve the quality of high school physics, chemistry, and biology teaching, learning, and assessment.

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Acknowledgement

This material is based upon work supported, in part, by the National Science Foundation under Grant No. 1561751. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.