Session Title:
Creating Coherence: How Developing an Observation Protocol Clarified and Aligned Our Thinking

MSP Project Name:
Boston Energy in Science Teaching (BEST)

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Project Session

Strand 3

Summary:
The NRC's Frameworks requires educators to rethink instruction and professional development using the lens of crosscutting concepts. The Boston Energy in Science Teaching project initiated a study of professional development and its impact on instruction and student learning using the cross-cutting concept of energy. The project team developed an observation protocol to document teachers' integration of energy concepts into their instruction, as well as missed opportunities. The development process revealed larger issues around language, depth and breadth of shared understandings relating to the concept of energy and how to teach it. This presentation will discuss how lessons learned shaped the protocol, clarified our thinking, and how they may help future efforts to incorporate other crosscutting concepts into instruction.

Section 1: Questions framing the session:
The National Research Council's release of *A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas* will require educators to rethink their instructional and professional development practices with a crosscutting concepts lens. Prior to the release of the *Framework*, the Boston Energy in Science Teaching (BEST) project initiated a study comparing concept-based to discipline-based professional development and its impact on instruction and student learning. The Boston Energy in Science Teaching (BEST) project is a National Science Foundation Phase II Math Science Project. The Phase I of the project looked at the impact of different discipline-based professional development strategies on teacher instruction and student achievement. BEST is currently engaged in researching the impact of concept-based professional development, as compared to discipline-based professional development, on changes in classroom instruction, as well as teacher content knowledge, student

engagement, and faculty research interests. Impact on classroom instruction is being determined by collecting classroom observation data; analyzing lesson plans, assignments, and student assessments; and through teacher interviews. This paper will focus on how to determine impact of professional development on classroom instruction through an observation protocol that looks for the use of crosscutting concepts.

Research participants are recruited based on their professional development involvement: discipline-based professional development, concept-based professional development, and both. At the beginning of the project, the research team explored observation protocol options (Fredericks et al, 2011; Jones, 2009) and tried to employ existing observation protocols, such as Reformed Teaching Observation Protocol (Piburn & Sawada, 2000) and Inside the Classroom Observation and Analytic Protocol (Horizon Research Inc., 2000). However, none of these tested protocols were designed to collect data to determine if a crosscutting concept—in this case energy—is being taught.

To determine this impact, the research team from Education Development Center, Inc., in collaboration with the BEST project team, created—and subsequently revised—an observation tool to determine the nature and extent of teachers' use of the crosscutting concept of energy during their science instruction. Developing the observation protocol was obviously necessary for the project, but it also became a compass of sorts, forcing the project team to discuss and clarify complex ideas regarding teaching, teaching well, and integrating the cross-cutting concept of energy into science instruction. In this paper, we will describe these issues—and the ongoing challenges the research and project leaders continue to encounter, as well as the potential for its wider value to the science education community as teachers start to incorporate the seven crosscutting concepts that have been identified *A Framework for K-12 Science Education* (NRC, 2011).

Section 2: Conceptual framework:

We propose this paper for Strand 3 because it demonstrates how the process of creating an observation protocol as a leadership team revealed areas where our thinking about teaching energy in an integrated manner diverged; and how the repeated cycles of reviewing videos of instruction, coding them together, and discussing our thinking clarified our vision of what we were trying to achieve, and how we would know whether and how close we are coming to our goal.

The observation protocol includes a pre-observation interview, which gathers basic information from teachers about their educational background, as well as information about what the researcher should expect to see during the observation, much like standard pre-interview protocol. It also includes several post-observation questions to clarify with the teacher any questions, and to get the teachers' perspectives on what occurred during the lesson. However, our contribution lies with the observation itself, a set of items to document teachers' inclusion of energy, as well as students' engagement during class. Upon initial design, the BEST project assumed that the employment of energy in the classroom would be obvious, and that the main focus of the research would be on *how* a teacher incorporated the energy concept into her daily lessons. However, there were several barriers that made the observations much more complex. First, it takes many cycles for a teacher to develop a sophisticated integration that goes beyond simply

mentioning energy during the lesson. Second, the researchers need to have enough knowledge about energy concepts to be able to identify all occurrences, connections, or misconceptions that take place during the lesson.

The observation protocol was developed to capture the ways in which teachers incorporated the crosscutting concept of energy into their instruction. The development process included input from both the research team and the leadership team. The leadership team provided a view of what quality instruction that integrated energy concepts would look like, and what would be observable in a class. The research team complemented that thinking with the literature on the expert-novice continuum. Together, with our practical shared understanding and the theoretical framework of expert-novice teaching, we worked to create an instrument that we could use in the classroom.

In its current form, the observation tool focuses on *occurrences of energy*. The researcher classifies each occurrence into one of three categories: simple reference to energy, discussion or exploration of energy concept, connections between concepts. The categories were designed to represent movement along the expert-novice continuum: those teachers who simply mention energy during their lessons would be towards the novice end of the continuum, while those who are making multiple connections between energy concepts and one or more of the science disciplines would be closer to the expert end. Another section of the protocol is for other references to energy, such as those made through examples from everyday life or analogies, as well as times when scientific terms around energy are used incorrectly by teachers, or when teachers miss opportunities for connections.

Section 3: Explanatory framework:

The process of creating the observation tool, as well as a method for coding and analyzing the data, was extremely challenging. Issues around language, different interpretations, content knowledge, and lack of shared understandings were key obstacles to overcome. These obstacles fell into the three categories below.

Vocabulary

One important issue became obvious at the outset: vocabulary, particularly the terms *content* and *concept* matters. The meaning of these words has evolved throughout the project and the lines still remain somewhat blurred. The words take on new meaning depending on when and where they are used, and with what adjectives. For example, energy is taught as biology content when students are taught that plants make food through photosynthesis. However, this same idea becomes a conceptual idea as you think about how energy is transformed from solar energy to chemical energy because it is an idea that can be transferred to other science disciplines. Some members of the team used them interchangeably; some had very distinct ideas about what separated them. Until we came to a shared understanding of what these words mean among all of us, they remained stumbling blocks that were encountered often.

Scope of Content Knowledge

Perhaps the greatest challenge in creating the observation tool was dealing with the extreme scope of knowledge inherent in this project. As the project progressed and the development of the tool began, it became clear that it would not be feasible for a single researcher—or member of the BEST project team—to have command over enough science content across all the disciplines and grade levels to be able to identify

connections to energy, missed opportunities, or incorrect usage of scientific terms. To address this issue, part of the classroom observation now includes audiotaping and transcription of the teacher during the lesson. The tape and transcriptions will allow the research team to draw on the abundant content knowledge of the leadership team to assist with coding and analyzing these data. Additionally, the research and leadership teams will view videos from Energy II participants teaching an energy concept in their classroom that were made during their participation in the Energy II course. Project team members will be able to listen for connections made within or between disciplines, identify missed opportunities to make such connections, and detect incorrect usage of scientific terms. This level of assistance with coding will provide a more exact and in-depth picture of teachers' understanding of energy concepts, how energy fits within the district's curriculum, what characterizes teachers' instruction on energy concepts, and the importance of making connections with and for students. Using the varied expertise of the leadership team for this purpose further underscores the importance of having a shared understanding of language, so that definitions of terms can be applied consistently among ourselves and with others.

Coding and Analysis

It has been clear from the beginning that the observation protocol would be a work in progress. While several issues have been resolved, there still remains work to be done. For example, we know that not all connections are created equal, but as a group we don't yet have a set of shared metrics for rating these connections. Are certain types of connections more desirable? Are specific missed opportunities more significant? The research team has met separately with members of the leadership team to review some videotapes, and during those meetings each person acknowledged that, although they identified what they considered to be an important missed opportunity, their colleagues might not consider it in the same way. There is not currently a shared understanding around these issues, so while the protocol itself may appear to be finished, a system for coding and analysis of the data is still evolving. Moreover, the fact that members of the leadership team represent a variety of science disciplines is both a strength and a challenge. We encounter first-hand our pre- and misconceptions about disciplines other than our own, as well as whatever biases we may not know we have. Where this kind of interdisciplinary approach may be a chosen one for other studies, it is by definition one that must mastered in the context of studying crosscutting concepts.

Section 4: Discussion:

The issues that came to light during the development of the observation tool were the result of a process in which the BEST leadership team had to verbalize their notions regarding how the cross cutting concept of energy could and should be taught across the science disciplines and grade levels, and what observable features would characterize strong and developing integrated understanding and instruction. These discussions necessarily revealed differences in our thinking that, had they not been identified, would have continually hampered our ability to understand and interpret the observation data we were collecting. By reviewing, coding, and discussing videos of instruction together, we created a shared, concrete, and foundational understanding of where we want BEST's professional development experiences to take teachers, and how we will know whether and how close we are coming to our goal.

The issues that were revealed during this process are also highly relevant to other educators and researchers – MSP and otherwise. As teachers think about how they might implement crosscutting concepts in their classrooms, as administrators plan professional development, and as researchers investigate classroom implementation of crosscutting concepts, the lessons learned from the BEST project will prepare them for the issues they are likely to face around language, measurement, and expert resources necessary for interdisciplinary work. In addition, the observation tool itself will help others recognize what implementation of crosscutting concepts is supposed to look like. Because integration of crosscutting concepts into instruction is supposed to be seamless, at this stage the main goal of the research is to identify occurrences. This will help us recognize what it looks like—in other words its occurrence—in the other six NGSS concepts. From there, we can move to a deeper level of understanding in determining different levels of connections, and which ones are worthwhile and which are not.

Section 5: How will you structure this session? What is your plan for participant interaction?

We will begin our session with an opportunity for attendees to briefly share a concept, theory, or model that has been central to their MSP's work, and that has also been challenging to operationalize. How did they know when members of their leadership team had divergent views, and how did that divergence affect the ability of the MSP to move forward effectively? Before we begin our presentation, we will ask attendees to listen for any strategies that they might use within their own MSP to reveal different perspectives and close the gap. We will then present our experience with the BEST observation protocol, paying particular attention to the challenges we faced in coming to a shared understanding of the observable characteristics of high quality teaching of energy. If there is time, we will conclude with a brief discussion of what attendees might try with their own leadership teams in order to move toward more cohesive thinking.