Session Title:
Developing a Conceptual Framework for Interdisciplinary Science Inquiry (ISI)

MSP Project Name:
UB/BPS Interdisciplinary Science and Engineering Partnership

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Feedback Session

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Summary:
The focus of our partnership project is on interdisciplinary science inquiry (ISI). However, data collected during our first year implementation suggest that majority of STEM faculty and K-12 science teachers do not have a good understanding of ISI. Thus, we undertook to develop a framework that explicitly defines ISI in order to help both university STEM faculty and school teachers in their future implementation of ISI. The proposed framework consists of four dimensions including science and engineering practices, crosscutting concepts, core disciplinary ideas, and drivers/contexts for interdisciplinary science inquiry. The objectives of this session are to share our preliminary framework of ISI and to listen to comments and suggestions to further develop this framework.

Section 1: Description of product, tool, process, curriculum, or instrument:
Our project, University at Buffalo/Buffalo Public Schools Interdisciplinary Science and Engineering Partnership (UB/BPS ISEP), aims at providing BPS middle and high school science teachers with professional development on interdisciplinary science inquiry (ISI). It is hoped that the increased knowledge and skills on ISI will enable the teachers to develop their pedagogical content knowledge on ISI in order to improve student science achievement. The core teacher professional development activity is research experience during the summer under the guidance of university STEM faculty and graduate students. During the first summer of the project funding in 2012, 62 teachers from 12 Buffalo Public Schools were involved in a variety of research experiences at UB and other partner sites (e.g., industry). Research assistants in science education observed these teachers and interviewed them about their experiences. STEM faculty hosts were also interviewed about their experiences while of hosting teacher research.
Despite the fact that the focus of the partnership is on interdisciplinary science inquiry, it does not appear that the summer research projects were all interdisciplinary. It seemed that members from STEM areas (faculty members and graduate students) were not aware of ISI, although their research projects were interdisciplinary. Similarly, participating teachers also struggled with what it means by ISI.

The above findings suggest that a framework that explicitly defines ISI would be helpful for both university STEM faculty and school teachers. To achieve that purpose, we started developing a conceptual framework for ISI, which will be used as a foundation for developing standardized measurement instruments on ISI knowledge and pedagogical content knowledge. The objectives of this session are to share our preliminary framework of ISI and to listen to comments and suggestions to further revise this framework. Suggestions for developing standardized measurement instruments on ISI knowledge and ISI pedagogical content knowledge will also be sought.

Section 2: Question, issue, or challenge that is the primary focus of the session:

Although the term “interdisciplinary” exists for a long time, the exact meaning of ISI in the literature remains unclear. Many other terms such as multidisciplinary, transdisciplinary and integrated science are used interchangeably (Richards, 2008; Czerniak, 2007; Davidson, Miller & Metheny, 1995). Czerniak (2007) states that a clear definition could provide the stimulus for the design and further research regarding the impact of ISI curriculum and instruction, which is the aim of this study.

The Berlin-White Integrated Science and Mathematics (BWISM) model (Berlin & White, 1994) provides an initial theoretical framework for this study. This model has six aspects: (a) ways of learning, (b) ways of knowing, (c) processes and thinking skills, (d) content knowledge, (e) attitudes and perceptions and (f) teaching strategies (Berlin & White, 1994). Out of these aspects, the first three aspects are directly applicable to our project, because we are mainly interesting in understanding how scientists view ISI as ways of learning, ways of knowing and processes and thinking skills. The following questions guided the development of our initial ISI framework:

1. What are scientists’ conceptions about ISI? Do they differ according to disciplines?
2. What are scientists’ views about different dimensions of the new framework for K-12 science education?
3. How do scientists envision their roles in supporting teachers in order to implement ISI in the classroom?

By answering these research questions, we hope to define characteristics of ISI that can be implemented in the K-12 classroom.

We interviewed all the scientists (19) involved in hosting teacher summer research. These scientists came from a variety of disciplines in sciences, engineering, medicine, pharmacy, and so on. Each interview lasted between 30 to 60 minutes. We transcribed each interview verbatim. Another data source was observations of teacher research sessions that were conducted over summer. Observations of these research sessions helped us understand how scientists are supporting teachers to understand and implement interdisciplinary science in their research projects.

We employed an inductive approach to analyze the data. Two rounds of data analysis were completed on each interview by at least two researchers. We started our analysis with first examining interviews with respect to understanding each scientist’s
conceptions about ISI. We also looked for instances in the interviews where scientists provided examples from their research areas indicating ISI. We also compared scientists’ responses across disciplines to understand similarities and differences in their views across disciplines.

Based on the our preliminary data analysis results, we found that although scientists may not be able to give precise definitions of ISI, they expressed their views about ISI that were in general consistent with the three dimensions of the new NRC conceptual framework (NRC, 2012). They also provided examples from their own research to support their views. Accordingly, we define ISI as a type of scientific activity that creates its own theoretical, conceptual and methodological identity in order to produce more coherent and integrated results a certain problem. We further propose that ISI consist of the following four dimensions:

1) Science and engineering practices that relate to the knowledge and skills scientists and engineers possess in order to solve scientific and engineering problems.
2) Crosscutting concepts that bridge the engineering, physical, life and Earth/space science. They provide an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world, thus represent knowledge about science and engineering as a way of knowing.
3) Disciplinary core ideas that are foundational to specific science (e.g., life science, physical science) and engineering disciplines.
4) Drivers/contexts of interdisciplinary research, which include the inherent complexity of nature and society, the desire to explore problems and questions that are not confined to a single discipline, the need to solve societal problems,, and the power of new technologies.

The above dimensions intend to capture that ISI is pluralistic in method and focus, is driven by scientific curiosity and practical need, and is rapidly becoming common in scientific and engineering research. We have further elaborated the above dimensions into a matrix with specific performance expectations from a novice level to an expert level. We will share this matrix with the audience and invite comments and suggestions to improve.

Section 3: Types of people who you think might be most interested in discussing this and offering feedback:
We anticipate that the following people will be interested in this session:

a. PIs with a focus of their project on scientific inquiry;
b. K-12 teachers who are interested in inquiry science teaching in the classrooms;
c. Higher education STEM faculty who are involved in teacher professional development;
d. Science education faculty who are doing research related to science inquiry in the classroom;
e. Evaluation researchers who are interested in measuring science inquiry.

Section 4: How will you structure this session? What is your plan for participant interaction?
We will give a brief introduction to our project background and the proposed ISI framework. We will then provide some examples of teacher/STEM faculty research
projects to demonstrate the framework. We will also state possible uses of this framework for our future project implementation and evaluation. The audience will then form small groups to brainstorm the following: (a) the validity of the framework, (b) utility to STEM faculty, K-12 teachers, and evaluation researchers, and (c) feasibility of implementation. The small groups will then gather as a large group again to share their ideas generated from their small groups. Finally, the presenters will describe how they will use the feedback from the audience to further develop the ISI framework.