

**Abstract Title: MOSART: From MSP to teacher to student**

**MSP Project Name: MOSART-LS**

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**120 word summary:**

This session focuses on two sets of research findings: [1] The effects of MSP institutes on teachers' subject matter knowledge and pedagogical content knowledge and [2] the effects of teacher knowledge on student gains. Misconceptions are robust but scientifically inaccurate understandings of the world that are often consistent with everyday experience. We have developed a unique approach to measuring teachers' SMK and PCK in a large scale study that clarifies the relationship between teachers' knowledge of misconceptions and students' gaining better understanding. To measure teachers' subject matter knowledge (SMK), teachers take the same test as their students. The second measure, pedagogical content knowledge (PCK), is revealed by asking teachers to predict the most common *wrong* answer chosen by their own students. We have analyzed data from more than 300 teacher participants engaged in more than 15 institutes in many states throughout the U.S.

**Section 1: Questions for dialogue at the MSP LNC.**

1. What characteristics of MSP institutes enhance teachers' subject matter knowledge and pedagogical content knowledge?
2. How does teachers' pedagogical content knowledge (knowledge of specific student misconceptions) affect gains in understanding made by their students?

**Section 2: Conceptual framework.**

The session we will present relies on studies from our research using MOSART instruments. MOSART (Misconception Oriented Standards-based Assessment Resources for Teachers) are multiple choice tests with distractors (incorrect options) reflecting common misconceptions. Misconceptions are robust, but scientifically inaccurate understandings of the world. The RETA projects of the Science Education Department at the Harvard Smithsonian Center for Astrophysics (MOSART, MOSART II, and MOSART LS) have focused on the development, validation and use of misconception oriented multiple choice assessments in K-12 earth, space and physical science (including high school chemistry and physics). We are currently finalizing our K-8 life science assessments, as well as launching our online assessments for MSPs and

revamping the MOSART web sites to enhance their ease of use and utility to various stakeholder groups (e.g., teachers, teacher preparation program faculty, and professional developers).

We have developed two simple measures of teachers' subject matter knowledge (SMK) and pedagogical content knowledge (PCK). To measure teachers' subject matter knowledge (SMK), we ask teachers to select the correct answer for each item, just as we do for their students. Their choice reveals their conceptual strengths and weaknesses. A typical teacher profile reflects overall strength in SMK, but while most teachers score highly on science items that they are responsible for teaching, some have weaknesses or "holes" in their knowledge. Our second measure focuses on a particular kind of pedagogical content knowledge (PCK) revealed by asking teachers to predict the most common *wrong* answer chosen by their own students. This ability to accurately choose the most popular misconception from four more or less plausible wrong answers requires an awareness of the most common conceptual difficulty encountered when teaching students a particular concept. The validity of these measures is grounded in the changes made by students depending on their teachers' SMK and PCK.

Our definition of student success is that student responses progress from random incorrect responses to the dominant misconception (when there is one) or a correct response. Examining students' and teachers' responses at the item level provides sufficient clarity to see the changes while total scores did not reveal this relationship.

### **Section 3: Explanatory framework.**

We have collected data in all K-12 physical sciences (and K-8 life science) throughout the United States. Since the initial funding of MOSART seven years ago, we have analyzed data from more than 300 teacher participants engaged in more than 15 institutes. Most institutes produced gains in SMK and, at times, in PCK. This research is therefore descriptive and usually pre-post. We have reported both item and standard-level gains to the programs. Our second set of findings is derived from more than 20,000 middle school students' gains from pre-test to the mid-year and/or year-end test administrations derived from our NSF-funded IMD assessment project, SPARCS. Although the samples are convenient clusters of students in volunteer teachers' classrooms, the demographic profiles of teachers and students suggest that these samples are reasonably reflective of science teachers and middle school students nationwide. While the MSP data are analyzed with typical parametric approaches (e.g., means, effect sizes and dependent t- tests), the analysis of the item data required a hierarchical logistical regression, rather than the general linear model. The size of the sample allowed this complex analysis to have sufficient power to ascertain statistically significant results. Our findings include the following:

1. Institutes vary in the pre-post gains made by teachers in both SMK and PCK.

2. Length of time spent on various participant activities, rather than more formal (passive) learning, improves both SMK and PCK.
3. Students taught by teachers who accurately respond to an item are more likely to change their conceptions than students of teachers who do not know the correct response.
4. Students of teachers who accurately predict the most common incorrect response to an item are more likely to reject that conception and embrace the scientifically correct response.

#### Key insights that have value for the Learning Network

1. With our new online testing system, we expect to provide early useful pre-test results to participating MSPs. The first report will be a “diagnosis” of participants’ areas of strength and weakness.
2. The use of MOSART assessments will allow us to compare the gains made by one institute's participants to other institutes targeting the same content and thus facilitate the sharing of practices.
3. Using robust, technically validated assessment data minimizes the problems of “apples and oranges” in comparing MSPs. In addition, entirely idiosyncratic measures are often qualitative, and may be biased, as well as difficult to evaluate. With a common evaluation suite, NSF can gain better understandings of what MSPs are accomplishing.