Abstract Title:
Developing Learning Progressions in Earth and Space Science as a Tool for Teacher Professional Development and Student Learning

MSP Project Name:
Targeted Math Science Partnership in Earth and Space Science

Author(s):
Scott McDonald, Tanya Furman and Christopher Palma

Presenter(s):
Scott McDonald, Tanya Furman and Christopher Palma

120 word summary:

To improve the quality of instruction and student learning in Earth and Space science we must have professional development that tightly integrates assessment (broadly construed), curriculum development and pedagogical improvement. This project focuses on developing innovative and integrated methods of research and practice centered around learning progressions as a tool for supporting all strands of teacher and student learning. Summer teacher workshops focus on development of LPs based on samples of student work and use these emerging LPs as guides to develop curriculum and formative assessments. During the school year teachers use these developed tools to experiment with new approaches to teaching ESS content and video record their attempts. The second iteration of teacher workshops incorporates those video records as a source for modified lesson study discussions.

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

  1. What is the structure/format for Learning Progressions that is most likely to support teachers' professional growth? Are there different forms for different professional goals (curricular, assessment, teacher content understanding, etc.)?

  2. What structure of supports (human, pedagogical, and technological) is useful in creating geographically distributed Professional Learning Communities focused on science teaching professional development?

  3. How do we integrate our work into the on-going work to develop standards at the national level (core curriculum) and with our Commonwealth Department of Education as they develop a Standards Aligned System for the Commonwealth?

- Section 2: **Conceptual framework**.

  Our work is grounded in the literature focusing on Learning Progressions (National Research Council, 2007) and the emerging body of literature on the structure of Learning Progressions (e.g. Mohan, L., Chen, J., Anderson, C.W., 2009) and their usefulness in supporting teacher learning (e.g. Furtak, 2009). We also draw on the extensive body of

literature that describes, both theoretically and empirically, excellent teacher professional development (e.g. DuFour, R., Eaker, R., Dufour, R., 2008).

Learning progressions are empirically based descriptions of how students' ideas around a conceptual area of science (e.g. plate tectonics) develop over time. Following the model proposed by Anderson and colleagues (2009), we will first work to establish an upper anchor for our learning progression. This is a description of what we believe students should understand to be able to be considered scientifically literate. This will be the primary work of our first, pre-workshop planning semester in the spring of 2011. We then plan to gather data near the end of spring 2011, primarily in the form of student work and video of classroom practice, as a way to establish how these ideas and their precursors develop across different grade levels. Much of this work will be done in conjunction with the teachers as part of the professional development process (Furtak, 2009). We will use these preliminary descriptions of students conceptual understand to help guide us to develop activities and formative assessments that teachers can use in their classroom to better understand their students' conceptual development. The student work from these new activities and assessments will be used as data in the next iteration of the learning progression. This cycle will continue each year, allowing us to fine-tune and enrich our descriptions of students' conceptual understanding across grade bands as they progress toward our upper anchor. Our notion of student success is grounded in these learning progressions. The formative assessments and associated student work will provide one source of data to allow us to evaluate the degree of student success achieved by students in our participant classrooms.

Our hypotheses include:

1. Conversations around student work, with the scaffolding of both content and pedagogical experts, will enable teachers to create useful artifacts in the form of learning progressions that can be grounded in the local context while also being generalizable across contexts.

2. Learning progressions can serve as productive tools to help teachers develop curricula, assessments, and instructional practices that better support student learning of Earth and Space Science content across middle grades.

3. In classes where teachers improve instruction both student learning and students' perception of ESS as a field will improve.

- Section 3: **Explanatory framework**.

This project attempts to provide new tools for helping teachers understand student success. Learning progressions, particularly as developed in concert with STEM faculty, offer the opportunity for teachers to develop rich understandings of their students' learning and its relationship to normative understandings of science content. Learning progressions developed by this project will be informed by authentic examples of student work that are evaluated by individuals with deep expertise in both science content and

education. This synergy provides an opportunity to develop a map of the conceptual terrain of students' understanding within the content focus areas of the project: energy, plate tectonics, climate change, and solar system astronomy.

The Earth & Space Science Partnership also hopes to develop innovative professional development opportunities that integrate curriculum, assessment and pedagogy. As a part of the project we anticipate developing research methods for examining the impact of these professional development opportunities on both teacher and student learning. Learning progressions developed within the context of this project will also provide an opportunity to describe learning trajectories for individual students as they develop understandings of the content. These trajectories can be useful to teachers and curriculum developers as a way to understand cases of individual student learning. The research design for this project incorporates multiple data sources intended to inform about the impact on student learning, student perceptions, and teacher learning. In order to inform student learning we will examine PSSA (Pennsylvania System of School Assessment) scores for students aggregated at the classroom level. Student work samples, which teachers will bring to the summer workshops, will be used for a more qualitative source of the impact on student learning. In addition there will be videotape of participant teachers' classrooms, which will provide a rich data source about the nature of students conceptual understanding, as well as their engagement in the practices of science in participant teacher classrooms. Data to inform future learning will include videotapes of all teacher workshops and evaluation of videotape of teachers practice provided as part of the workshop experience. We will use this data along with complementary data from the PSSA to triangulate on the nature and quality of student achievement of our definition of success. We will be able to use rich learning progressions data as a way to guide our professional development work and more traditional learning outcome data, such as PSSAs to allow comparisons to peers and commonwealth benchmarks.

The project hopes to impact not only the conceptual understandings held by students and current and future teachers, but also their views of and affinity toward Earth and Space science as a career path or simply as an informed citizen. We will work within partner districts to increase the visibility of Earth and Space Science, to encourage high-achieving students to enroll in Earth and Space courses, and to provide student- teaching opportunities for pre-service teachers from a newly invigorated undergraduate program in secondary education. One feature of our longitudinal study involves authentic research experiences developed in partnership between Upward Bound Math Science and faculty members in our academic colleges. Summer Experiences in Earth and Mineral Sciences and in the Eberly College of Science (SEEMS, SEECoS) provide research opportunities for high school students – some from partner teacher classrooms – and mentoring opportunities for pre-service teachers working in tandem with STEM graduate students; this program helps build a pipeline for retaining first generation and low income students in science classrooms and careers. From the research perspective, by studying the work of the student participants, we gain insight into an extended learning progression that encompasses the college grades as well as middle and high school.

We hope to provide insights into how learning progressions can be a useful focus for professional development. In particular we hope to be able to share best practices around the use of LPs in professional development and also how they can guide the development of formative assessments teachers can use to improve student outcomes. We also hope to provide insights regarding research methods for studying the impact of LP-based professional development activities on teachers and their students' learning. It is also our goal to work in partnership with the Pennsylvania Department of Education to promote deep understanding of Earth and Space science as part of the Standards Aligned System within the public schools.

References

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