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

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.

How do we define student success?

We define student success in terms of two key characteristics:

- Conceptual understanding - movement toward a deep and rich understanding of a big idea in science described in the upper anchor.
- Affiliation for Science - increased appreciation of the value of earth and space science as a field of study.

We intended to measure student success using multiple measures for each of the two characteristics of success:

- Conceptual understanding - (1) Learning progressions are a way to characterize students' conceptual understandings across grade levels around a big idea in science. They will help guide the development of new assessments for students' deep, rich conceptual understanding. (2) Standardized exam scores will be used to evaluate student success relative to their peers.
- Affiliation for Science - (1) Increased enrollment in Earth and Space Science courses, especially by college bound students. (2) Students in Earth and Space Science courses continuing on into other science courses at higher rates.

Our goal is to develop or contribute to learning progressions in our four core areas of focus: Climate (Change), Plate Tectonics, Solar System Astronomy, and Energy. We begin this work of defining student success in terms of learning progressions by developing upper anchors for each of the four areas. Our next step will be to develop baseline assessments to be used by our participant teachers this spring to allow us to begin work on the empirical part of the learning progression this summer. It is our plan to present preliminary learning progression for each core area at next year's MSP LNC for feedback from the community.

While testing and other forms of assessment are useful for evaluating students' current understandings, they don't give a broader and more complex sense of where students are on a map of conceptual territory across grade levels. This means that learning progressions and assessments, especially formative assessments, can be used together to not only evaluate students' current state of understanding, but also to get a sense of their potential trajectory, both back into the past and forward into the future. More traditional assessments used in conjunction with learning progressions have the potential to provide an invaluable tool for supporting curricular and pedagogical planning in dynamic ways.

What is a Learning Progression?

A learning progression can be visualized as a map of students' conceptual understandings across grade levels around a big idea in science. Key components include:

- *Upper Anchor* - a **socially defined** goal for what we want our students to understand to be considered scientifically literate within our target concept .
- *Student Conceptions* - these are **empirical**, collected from students' actual conceptions. Relationships between normative conceptions, misconceptions, partial conceptions, and preliminary conceptions are hypothesized.
- *Lower Anchor* - also **empirical** indicating what initial conceptions students have within the target concept.

Learning progression are intended to be descriptive, compact, coherent and **incomplete**.

Upper Anchors

Energy

The earth's useable energy manifests itself in a variety of forms, some of which can be harnessed for human use. Interactions between forms of energy, including imbalances resulting from human use of resources, can be explained via the law of conservation of energy.

Plate Tectonics

Large-scale motions of both solid and near-solid earth materials can be explained as a natural consequence of the initial formation of the planet from an array of meteorites, the subsequent differentiation of the planet into chemically distinct units (crust, mantle, core), and the continual transfer of heat from the interior of the planet to the surface.

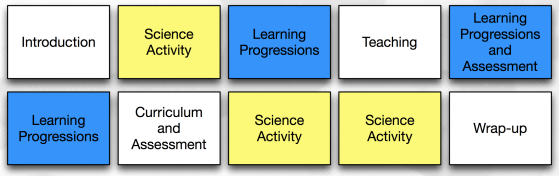
Solar System Astronomy

Astronomical phenomena observed from an earth-based perspective (such as the patterns of apparent daily motion, seasonal changes, and the phases of the moon) can be explained using the earth's rotation and tilt, the earth's orbit around the sun, and the moon's orbit around the earth.

Climate

Earth's climate is a dynamic system that can be explained as the result of the redistribution of energy, mass and momentum around the globe. The climate system involves and responds to interactions between the geosphere, biota, the atmosphere and oceans, and to internal (e.g. greenhouse gases) and external (e.g. solar energy) drivers that operate over a wide range of temporal and spatial scales.

Workshop



The pattern for the professional development workshops will be the same across the four focus areas.

- Gather preliminary data in spring 2011
  - student work samples from assessments developed by the research group
  - video of classroom practice.
- Engage teachers in year long content focused professional development
  - develop learning progression within a focus area
  - develop of curricular activities and formative assessments to inform a second round of data collection

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.

TARGETED MATH SCIENCE PARTNERSHIP ON EARTH AND SPACE SCIENCE

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