Abstract Title: Using Learning Progression Frameworks and Assessments to Guide Research and Professional Development

MSP Project Name: Targeted Partnership: Culturally relevant ecology, learning progressions and environmental literacy

Author(s): Charles W. Anderson, Michigan State University; John Moore, Colorado State University; Alan Berkowitz, Cary Institute of Ecosystem Studies; Ali Whitmer, Georgetown University

Presenter(s): Charles W. Anderson

120 word summary:

We have three goals in this session: 1) we explore the development and use of learning progression frameworks and assessments focused on environmental science literacy, with strands focusing on carbon cycling, evolution and biodiversity, and water systems and cycles, and 2) we discuss how we have used learning progression research to formulate goals for student learning, develop teaching materials, and guide professional development, and 3) we discuss the challenges of organizing a large, geographically dispersed project around a new approach to educational research and assessment.

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

1. What have we learned about students' environmental science literacy, and about learning progressions leading to environmental science literacy?
2. How can we use learning progression research to formulate goals for student learning, develop teaching materials, and guide professional development?
3. How can we organize a large, geographically dispersed project around a new approach to educational research and assessment?

- Section 2: **Conceptual framework**.

We define student success as *Environmental Science Literacy*—the capacity to participate in and make decisions through evidence-based discussions of socio-ecological systems—is essential for many STEM careers and for responsible citizenship. Environmental science literacy requires citizens to understand, evaluate, and respond to multiple sources of information. Development of an Environmental Science Literacy Framework requires that we understand the current state of knowledge of teachers and students in these core areas, and understand the scaffolding of science and mathematics concepts, or learning progression, required to reach the desired level of understanding. For us that does not imply any particular political position, but it does mean two things. Citizens should be able to:
- Understand and evaluate experts' arguments about environmental issues.
- Choose policies and actions that are consistent with their environmental values.

Learning Progressions - as defined by The National Research Council are "… descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as students learn about and investigate a topic over a broad span of time" (NRC, *Taking Science to School,* 2007). Learning progressions include (a) frameworks describing the development of student knowledge and practice, (b) formative and summative assessments aligned with those frameworks, and (c) teaching approaches that support students' learning. We have been working to develop learning progressions in three interconnected content domains:

- *Carbon.* Carbon-transforming processes in socio-ecological systems at multiple scales, including cellular and organismal metabolism, ecosystem energetics and carbon cycling, carbon sequestration, and combustion of fossil fuels. These processes: (a) create organic carbon (photosynthesis), (b) transform organic carbon (biosynthesis, digestion, food webs, carbon sequestration), and (c) oxidize organic carbon (cellular respiration, combustion). The primary cause of global climate change is the current worldwide imbalance among these processes.
- *Water.* The role of water and substances carried by water in earth, living, and engineered systems, including the atmosphere, surface water and ice, ground water, human water systems, and water in living systems.
- *Biodiversity.* The diversity of living systems, including variability among individuals in population, evolutionary changes in populations, diversity in natural ecosystems and in human systems that produce food, fiber, and wood.

- Section 3: **Explanatory framework**.

We have developed our learning progressions through an iterative research process focused on three broad goals:

- *Developing and validating learning progression frameworks.* We develop and validate frameworks describing how learners can make the transition from intuitive or force-dynamic reasoning by middle school students to a level of environmental science literacy needed by informed citizens.
- *Developing assessment resources* tied to these frameworks, including on-line and paper-and-pencil written assessments and clinical interviews. These assessments provide an empirical basis for the framework and rich descriptions of the knowledge and practice of learners who are diverse with respect to culture, age, and approaches to reasoning about phenomena.
- *Teaching experiments* to study sequences and mechanisms of conceptual change at the middle school and high school levels. Our teaching experiments include both classroom teaching materials and materials for professional development.

In this session we will discuss how we have organized the development of learning progression frameworks, assessments, and teaching materials and used these processes and products to coordinate our work across four geographically and culturally disparate locations: Baltimore, Santa Barbara, rural Michigan, and rural Colorado. The data from our assessments was used as a basis for teaching materials and professional development workshops. We have created systems for online data collection, and analyses of data from Year 2 teaching experiments are the basis for revisions of our approaches in Year 3. Our research design also calls for summative evaluation of student learning at these locations. We will also discuss the challenges of

organizing a large, geographically dispersed project around a new approach to educational research and assessment, including both our successes and our continuing challenges.

Our assessments and frameworks are available online through MSPNet and at http://edr1.educ.msu.edu/EnvironmentalLit/index.htm.