

**Session Title:**

Learning Progression-based Teaching Strategies (LPTSs) for Environmental Science:  
Alignment of Instructional Goals with Student Outcomes

**MSP Project Name:**

Culturally Relevant Ecology, Learning Progressions and Environmental Literacy (LTER)

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**Project Session****Strand 3****Summary:**

We have four goals in this session: 1) we describe the development and use of learning progressions to explore how students and teachers build environmental science literacy across four strands - carbon cycling, biodiversity, and water systems, cycles and quality, 2) we present results of assessments of student and teachers across the strands, 3) we present results of assessments of teacher goals for content and student learning, and 4) discuss how we have used our research and assessments to formulate models of Learning Progression-based Teaching Strategies for use in classroom instruction and teacher professional development.

**Section 1: Questions framing the session:**

Our project focuses on learning progression research in environmental literacy by focusing on the carbon cycle, biodiversity, and water. Our work is motivated by the need to support students in developing the scientific reasoning practices necessary to participate in individual and collective decision-making about ecological systems. Learning progressions are descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate a topic over a broad span of time. Learning progressions are anchored at one end (lower anchor – Level 1) by the ideas and ways of reasoning that students bring with them to school. At the other end (upper anchor – Level 4), learning progressions are anchored by

expectations of what we would like students to know and be able to do as scientifically literate citizens.

The following questions frame our session:

*Question 1:* What knowledge, skills and practices do students need in order to understand and predict the capacity of future ecosystems to provide essential services in the face of human caused environmental change, and the consequent implications in their roles as citizens (individual and social)?

*Question 2:* What learning experiences help students move upward through the transitions of a specific environmental learning progression?

*Question 3:* What knowledge, skills and practices do teachers need to foster this learning in students?

*Question 4:* What professional development practices and supports are needed to support this teaching? To address these questions, we have identified a suite of co-dependent development and research goals.

## **Section 2: Conceptual framework:**

Our project best relates to the “Evaluation, Research and Implementation: The Feedback Loop” conference strand.” The development of a learning progression framework by its nature is an iterative process involving assessments, interpretations and evaluation of responses, and refinement of the framework.

Initially our research focused on students and their responses. We were encouraged after our first annual report and in advance of our mid-project review to consider ways to include teachers in the assessments and how our research might influence teacher professional development and classroom practice. Inclusion of teacher responses to the mix offered important findings about student learning and teacher practice; leading to the concept of learning progressions-based teaching strategies.

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

We will present examples of learning progressions developed from carbon, biodiversity, and water strands that involved over 2,000 students and 100 teachers from grades 6-12 from schools in 5 states. Our learning progressions for each strand possess four levels that share common features.

*Level 1: Force-Dynamic Reasoning with Anthropomorphic Narratives* – Respondents will explain the environmental phenomena through narratives with objects (e.g., animals) as characters that interact in human ways.

*Level 2: Narratives with Hidden Mechanisms* - Respondents recognize that phenomena occur in response to environment conditions, but the mechanisms are ascribed to different “conditions” in a vague sense.

*Level 3: “School Science” with Phenomenological Narratives* - Respondents understand that environmental phenomena are governed by underlying physical, chemical and

biological principles, but do not use principles or core ideas consistently, leading to non-canonical models.

*Level 4: Principle-based Reasoning with Mechanistic Narratives-* Respondents identify and apply multiple principles that are most important at the appropriate spatial, temporal, and organizational scale.

Our research demonstrates two major transitions in the way in which respondents view, make sense of, and describe the environment. First, as respondents develop more sophisticated understandings, their discourse changes from descriptions of phenomena in terms of actors and enablers within scenes (Levels 1 and 2) to descriptions that are based on and that are governed by underlying ecological principles (Levels 3 and 4). The second transition occurs within the students who have adopted scientific reasoning. Early adopters use descriptive phenomenological (Level 3) tone in their discourse, while more seasoned adopters use hierarchical and mechanistic reasoning (Level 4) in their discourse. In the later case, scientific-based descriptions and the underlying principles and mechanisms are imbued with an understanding of the basic principles manifest themselves at the scale of interest.

For all assessment items, most students scored at Level 1 and Level 2, and few (often < 10%) of students were reasoning at Level 4 (the highest level of our progression) and high school students performed marginally better than middle school students. Surprisingly, the majority of teachers scored at Level 3.

Surveys of teachers that asked about the learning goals for their students revealed that the majority of teachers focused on the content and underlying principles in ways that were likely to foster Level 3 reasoning.

#### **Section 4: Discussion:**

We will highlight three important findings.

1) The focus on using grounded research to describe students' ideas and ways of thinking about topics is one key characteristic that differentiates learning progression frameworks from scope and sequence science standards documents developed in the past. The current and proposed science standards implicitly and explicitly require students to understand topics at Level 4 of our learning progression.

2) We have learned that students are not able to apply principle-based reasoning in a Level 4 manner across multiple spatial, temporal, and organizational scales to interpret environmental issues and topics. The learning goals that teachers set for their students often reflected Level 3 reasoning.

3) Our research indicates that learning progressions can help teachers and science educators use knowledge of students' ideas to inform instruction, instructional planning and curricula development. From this, we developed the concept of learning progressions-based teaching strategies.

**Section 5: How will you structure this session? What is your plan for participant interaction?**

1. We will begin by having participants take a short survey on what their learning goals for students would be for a topic (arranged by table) in one of the three strands (carbon, biodiversity, and water).
2. Participants will then discuss their responses with others at the table.
3. We will present our findings using a traditional PowerPoint format.
4. We will then ask each table to reflect on their discussions in light of our findings.