SYSTEMS THINKING AND LEARNING PROGRESSIONS: FRAMEWORKS FOR ENVIRONMENTAL LITERACY

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Abstract: Ecosystem science like all sciences evolved from a descriptive natural history-based beginning to one that is systems-based integrates multiple principles across multiple scales. The systems-based approach adopted by ecosystem scientists has provided insights into natural and human impacts on the earth system processes governing soil formation, hydrologic and biogeochemical cycles, biodiversity, and community structure and dynamics. This approach has shaped research into the science and environmental literacy realm as well. How students learn and apply this knowledge is a critical component of environmental literacy. Most students are unprepared to critically evaluate evidence-based arguments about the environment because they do not understand the principles that govern environmental processes and are unable to reason across hierarchical scales of biological organization. Using our learning progressions-based approach we have found consistently across topics that most MS and many HS students give “force-dynamic” descriptions that frame events in terms of actors trying to achieve purposes. Few MS and HS and most undergraduate students transition to “scientific model-based” explanations wherein events and phenomena are constrained and governed by underlying scientific principles. Students who are just beginning to use “scientific” reasoning use a descriptive tone in their discourse that involves naming and describing events and processes, but that falls short of explaining phenomena using scientific principles (e.g., students may describe that plants make food, but fail to conserve carbon atoms through processes such as photosynthesis and cellular respiration). The transition undertaken by more seasoned adopters is to use hierarchical and mechanistic reasoning in their discourse, wherein explanations draw on underlying principles and mechanisms that convey an understanding of how the basic principles manifest themselves at the scale of interest and across scales of organization. The ability to adopt and use system thinking is critical in our quest for a literacy framework to guide our instructional goals and practices.

Workshop Description

Learning progressions - Descriptions of how students develop increasingly sophisticated understandings of topics.

The workshop will illustrate a learning progression approach to understanding students (grades 6-16) develop a more sophisticated understanding of environmental concepts related to water, biogeochemical cycles and biodiversity. The approach works within a literacy framework that captures the complexity of environmental issues—1) an understanding of the environmental content and underlying principles involved, 2) the ability to apply hierarchical reasoning that connects the content and principles in a system context across multiple temporal and spatial scales, and 3) the capacity to
participate in and make decisions through evidence-based discussions and communicate findings to diverse audiences. We will examples on how we have developed and used learning progression frameworks, assessments, and instructional resources to guide instruction and curriculum development. We will work through the process of 1) developing a set of progress variables, based on topics that are important for understanding environmental issue, 2) establishing the upper anchor of the learning progression describing for each progress variable based on the knowledge and practices that experts believe students can and should have at grade, and 3) developing assessments to empirically determine the lower anchor, what 6th grade students know, and the intermediate level descriptions in the progression to the upper anchor. The frameworks have helped in the design of instructional resources for middle school, high school, and college, and in the design of curricula writ large, and in the development of instructional practices designed to recognize where students are within the progression and how to move them toward the upper anchor.