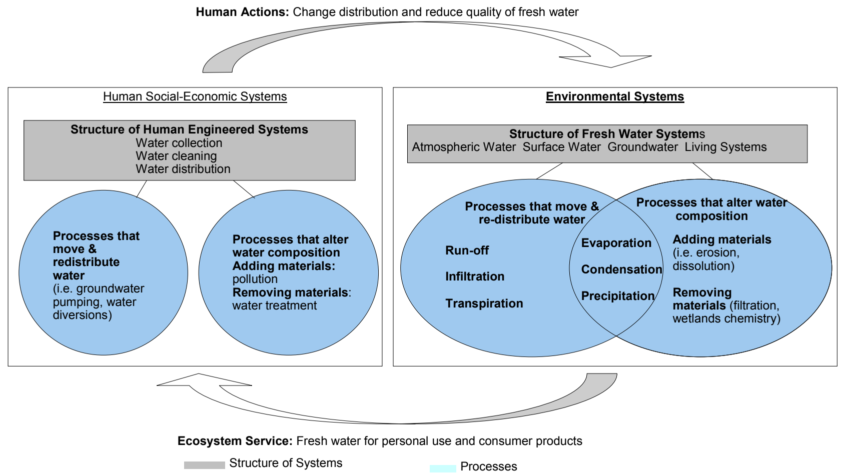
Developing a K-12 Learning Progression about Water in Environmental Systems

Kristin L. Gunckel, Beth A. Covitt, Hasan Abdel-Kareem, Rebecca Dudek, Charles W. Anderson
Michigan State University

ENVIRONMENTAL LITERACY

Water in Environmental Systems



Methodology

- Administered approximately 875 assessments
- Questions addressed all aspects of water in environmental systems
- Assessments tailored to class focus (i.e. chemistry, groundwater, watersheds, general)
- Conducted 10 interviews of high school students about groundwater & watersheds.
- Classes sampled
  - 2nd-12th grade
  - Urban, suburban, rural schools
- Analysis
  - Sampled 20 responses for each question across age and location range
  - Ordered and grouped questions to develop characteristics for learning progression

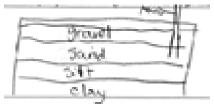
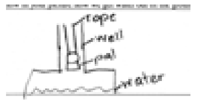
Water Curriculum Materials

When teaching about water, some teachers chose to use curriculum materials developed through CCMS. Although this research did not focus on the effect of these materials, the materials provided a context that allowed for the collection of responses related to the specific aspects of the water cycle framework.

Water for People & the Planet – Examines groundwater, watershed, and engineered systems. Addresses the questions, "Where does our water come from?" and "Where does it go?" Uses an inquiry-application approach. Includes embedded assessments for teachers. Co-generative dialogues with students were conducted during development to include student perspectives on water-related issues and instructional activities.

Mixtures & Solutions – Explores powers of ten and properties of suspensions and solutions. Addresses the questions, "What is in our water?" and "What is the best way to clean water?" Uses an inquiry-application approach.

Learning Progression

Level	Title	Characteristics	Structure of Systems **Groundwater Question:** Draw a picture of what you think it looks like underground where there is water. Also, show in your picture how we get water out of the ground.	Processes that Move Water **Puddles Question:** After it rains you notice puddles in the middle of the soccer field. After a few days you notice that the puddles are gone. Where did the water go?	Processes that Alter Water **Polluted Water to Rain:** Does polluted lake water turn into polluted rain? Explain why or why not.
7	**Quantitative Uncertainty & Change**	Can explain sources and quantitative estimates of uncertainty in projections of water supply or water quality associated with climate change or human management of watersheds and groundwater.			
6	**Quantitative Model-Based Accounts Across Scales**	Quantitatively traces water and materials in water through systems at multiple scales. Relates quantitative measures of concentration of materials in water to measures of mass and effects of purification processes.			
5	**Qualitative Model-Based Accounts Across Scales**	Uses models to trace water and materials in water along multiple pathways through systems at multiple scales. Relates atomic-molecular models of solutions and suspensions to water quality and macroscopic and large-scale processes.		The water did one of two things. Either it seeped into the ground (which needs no evaporation) or it was evaporated. Heat from the sun provided energy to the molecules speeding them up. With the increase the molecules have a less rigid structure and the water becomes water vapor.	
4	**School Science Narratives of Processes**	Uses spatial visualization to trace matter through systems and explain mechanisms of flow. Associates water quality with dissolved or suspended materials, but not specific about chemical identity or atomic-molecular models.		Some water is evaporated, some of it is absorbed in the ground, and goes into the ground water.	When water evaporates, only the water leaves and the pollution is left behind.
3	**Causal Sequences of Events with Hidden Mechanisms**	Recognizes that a mechanism is required to move or change water, but mechanisms provided do not account for limitations of processes or systems. Associates water quality with conditions or non-specific materials (e.g., "chemicals").		It dissolved in the ground because of the heat.	Yes. Because when water evaporates it turns into water vapor which then condenses into clouds. When the temperature drops and precipitation occurs the pollution form the lake that transferred into the cloud has now but transferred into the precipitation.
2	**Events-Based Narratives**	Uses iconic visualizations and representations, usually about visible parts of systems, but does not recognize hidden mechanisms for events. Characterizes water quality in broad terms—good or bad.		Water on the ground goes into the clouds one day.	No. The polluted lake couldn't turn into polluted rain because the rain is fresh and the lake could be polluted with garbage.
1	**Human-Based Narratives**	Explains what happens to water in terms of human needs and agency.	We need to have a lot of water.		

Center for Curriculum Materials in Science (CCMS)

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A K-12 LEARNING PROGRESSION TO SUPPORT UNDERSTANDING OF WATER IN THE ENVIRONMENT Beth Covitt & Kristin Gunckel CCMS Knowledge Sharing Institute July 10, 2006 MICHIGAN STATE UNIVERSITY. Tracing water in environmental systemsÂ Developing a carbon cycle learning progression for K-12Â TRACING CARBON IN ENVIRONMENTAL SYSTEMS Living systems follow the basic principles of physical and chemical change, including conservation of mass and conservation of atoms Organisms are made mostly of water and organic substances Organic substances consist of molecules with reduced C plus H, O, and a few other elements Virtually all reduced C is created from CO2 and H2O through. Developing scientific literacy about water systems is critical for Kâ€12 students. However, even with opportunities to build knowledge about the hydrosphere in elementary classrooms, early learners may struggle to understand the water cycle (Forbes et al., 2015; Gunckel et al., 2012; Zangori et al., 2015; Zangori et al., 2017).Â Teachers participated in professional development that introduced them to a learning progression for water in environmental systems and curriculum materials based on this learning progression. Teachers completed written assessments of their CK and PCK prior to the workshops and a year later. 2009, p. 8). Learning progressions in environmental literacy support a broad public consensus about the value of understanding ecosystem functions, even though the public demonstrates a poor understanding of ecosystems.. The progressions aim to address the pressing real-world need to understand the consequences of current actions on the future of that ecosystem.Â They move science out of its current silos of biology, chemistry, earth systems, and physics into a more integrated STEM (Science, Technology, Engineering, Mathematics) approach focused on the application of science in real-world contexts. Despite the focus of quantitative reasoning on applying mathematical skills and analysis of data through statistical processes, QR is not the same as mathematics or statistics. Framework for K-12 Science Education represents the first step in a process to create new standards in K-12 science education. This project capitalizes on a major opportunity that exists at this momentâ€”a large number of states are adopting common standards in mathematics and English/ language arts and thus are poised to consider adoption of common standards in K-12 science education. The impetus for this project grew from the recognition that, although the existing national documents on science content for grades K-12 (developed in the early to mid-1990s) were an important step in strengthenin...