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

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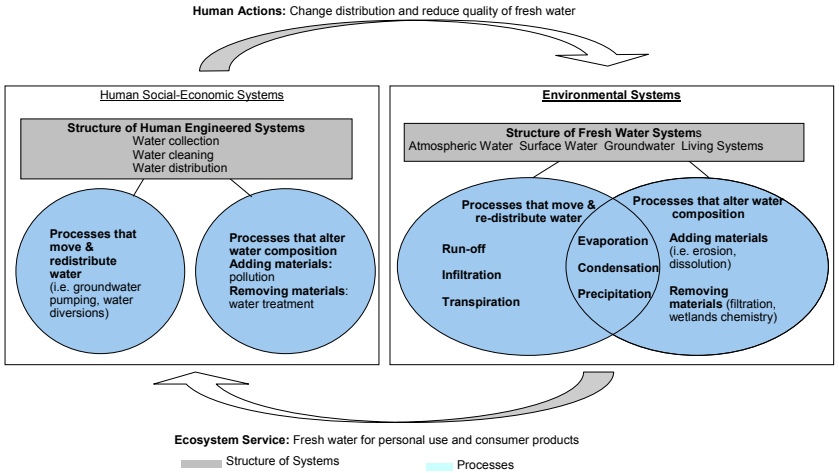
ENVIRONMENTAL LITERACY

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

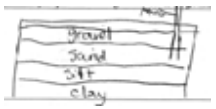
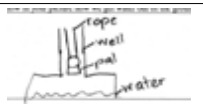
Water Curriculum Materials

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	Processes that Move Water	Processes that Alter Water
			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.	**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?	**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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