Ground Water Is Not A Priority

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The science education community has only recently begun to examine the way in which principles of ground water occurrence and movement are taught and learned. Results from these studies (see Dickerson, D.L. & Dawkins, K.R. (2004). Eighth grade students' understandings of groundwater. *Journal of Geoscience Education, 52* (1), p. 178-181. and others at www.odu.edu/~ddickers/) indicate that alternative ideas relative to those held by the scientific community flourish regardless of geography, socio-economic status, race, gender, and age in the US. The majority of these ideas involve inappropriate mental models that impose surface-oriented hydrologic structures and processes on subsurface environments and/or employ inaccurate ideas of scale. For example, children and adults commonly picture most ground water as literally occurring in large underground rivers or lakes that are contiguous bodies of pure water that look exactly as they do above the ground and either sit stagnant or flow between a layer of soil and a layer of rock. Such conceptions are common even after successful completion of introductory undergraduate geology courses. Most of these students, however, describe ground water using scientific terms such as porosity and permeability, yet the application of appropriate scale is another issue as many of these students identified a typical pore size to be on the order of kilometers. Additionally, for most children and adults the notion of fluid and gas movement in solid rock (as opposed to unconsolidated materials) and the forces responsible for ground water movement remain mysterious.

Alternative ground water conceptions change little throughout the course of most people's education and development of a complete and appropriate understanding of ground water without direct instruction appears highly unlikely. Providing effective instruction in K-12 classrooms is problematic, however, as most teachers hold inappropriate understandings of ground water. Because of the variety of traditional and alternative teacher education/licensure programs within and across universities, states, and the nation, geology course requirements for teachers vary. Specialized courses (e.g. hydrogeology) are rarely ever required of teachers primarily because teacher licensure programs result in a comprehensive science license rather than one focused on a specific science discipline. Furthermore, the concepts these teachers are required to know in order to provide instruction aimed to meet the goals described in local, state, and national standards are assumed to be addressed in one or two introductory courses in a variety of science disciplines. This assumption is incorrect in the case of ground water.

The issue of competence in teaching ground water principles is further complicated because in the world of formal science education, ground water is not a priority. A prime example involves the National Science Education Standards (a document from which the majority of the states and school systems in the country develop goals for K-12 science instruction), which call for a complete and appropriate understanding of water cycle processes. However, their depiction of a water cycle focuses almost entirely on surface-oriented processes. In fact, the term ground water is never mentioned in the document. Instead, as opposed to repeated references to surface-oriented processes involved in the water cycle, sub-surface processes are explicitly referred to only once as water that collects in “soil, and in rocks underground” (National Research Council. (1996). National science education standards. Washington, DC: National Academy Press, p 160). The practical implication for classroom instruction is that ground water concepts become marginalized, or worse, expendable. As adults, this lack of understanding translates into the inability to make informed decisions as voters, parents, and citizens regarding personal and public health, environmental stewardship, and sound economics.

Readers of *Ground Water* understand better than any other group the importance of ground water to the health and prosperity of the public. It is critical that you get involved in education. We propose three areas of initial involvement: 1) practice and encourage teaching for deeper understanding of ground water concepts using examples that stress appropriate scale, particularly in introductory courses; 2) lobby for more explicit inclusion of ground water in standards and curricula at the state and national level, and; 3) work with science educators to provide professional development opportunities for practicing science teachers. Such efforts have proven successful in the past. For example, in 1999 the Education and Industry Committee for Earth Science in North Carolina, a group composed of earth scientists and science educators successfully lobbied for an earth/environmental science requirement for all graduates of NC public high schools. A similar group of informed and devoted hydrogeologists and educators can do the same to make ground water a priority in science education.

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