Issues in Earth Science
"Topics for Debate"
Issue 2, Nov 2014

For Issue 2, we have two articles addressing Earth Science in Public Education. In *Value Play*, Jennifer Lepper considers the importance of family fun. In *Use It or Lose It*, Wade Gavin considers the true purpose of science education.

Value Play

by
Jennifer Lepper

How one values our Earth is in direct proportion to how one studies her. Both my husband and I are Geology teachers so, as you may guess, we are already deeply invested in Earth Science and believe that studying the Earth has intrinsic value. The summer of

2014, my husband and I decided to take our 14 year old son and 11 year old daughter to Yellowstone Park in Montana and Wyoming and to experience a 'western ramble'. A 'western ramble' is an adventure that is loosely guided by a road atlas and refined by a topographic map as one would find in a state "Gazetteer" publication. The spirit of the western ramble is that there is a general destination to reach--such as the mountains in Montana--but there is no strict timetable, and detours and diversions are welcome. We began taking such rambles during our summers in graduate school, when we had little money but a wealth of time. During the school year we saved all that we could for summer road trips. We let our trips evolve, following our interests in geology; from mineral collecting to seeking less frequently visited places of geological interest such as the Black Canyon of the Gunnison River in Colorado or the Channeled Scab Lands of eastern Washington state. We would read about where to find garnets in Colorado and along the way we would stop off in Leadville, CO to look for galena and other gangue minerals on abandoned tailings mounds; between Leadville and the Climax molybdenite mine on

Highway 91 we found a location to collect Carlsbad twins, (twinned orthoclase feldspar crystals).

Back to our family trip. We planned to go to Yellowstone, but were open to exploring other places. As we anticipated, the kids were wowed by the geyser basins in the park; it is easy to be interested in phenomena that are so unusual and dramatic. We spent two days in Yellowstone, then headed to Butte, MT to see the Berkeley Copper Pit, the World Mining Museum and the mineral museum at Montana Tech (formerly the Montana School of Mines). Driving on the highway doesn't offer as many chances to stop and look at the rocks safely, so we took the secondary roads, particularly one that was described in our Roadside Geology of Montana book as being lined with spectacular metamorphosed, Precambrian, basement rock.. Our children's interest began to wane as the miles and the geo-speak jargon increased. We stopped at a pull out next to the Madison River to take some pictures of the highly contorted gneiss lining the canyon; at this point, the kids were in open protest and didn't even want to get out of the car. We decided not to nag them and, after getting our pictures and speculating on the history of the rocks, went to wade

in the river to look at the large cobbles that formed the riverbed. When our kids saw us "playing" in the river, they got out of the car and came over to join in. We were bringing up rock after rock of different petrographic origin, shapes and colors, and the kids finally caught the rock collecting bug themselves.

It is obvious that my husband and I value Earth Science and seek to engage our children in learning about the Earth and her processes. However, we are in the minority. While we have endeavored to get our children out from under florescent lights and get dusty and muddy outdoors, many parents do not share this interest. As with any foundation in education, a strong foundation for learning begins at home and with play. Teachers are at an inherent disadvantage because they cannot control what their students bring from home in terms of interests or knowledge. As educators, we are seeing that our students have missed critical steps in learning. Opportunities for hands-on activities have declined with shrinking budgets, increased class sizes, and over emphasis on "virtual learning". The question of teacher training looms large in this debate. Is it necessary for all teachers to have training in Earth Science? I would argue

yes. However, classroom time is not sufficient. Educators must participate in field experiences as part of their education. Endeavoring to give a sense of play in teaching Earth Science is crucial, as my husband and I discovered with our own travel-weary children. Younger children can make their own 'rocks' out of inexpensive materials and make geologic structures such as folds and stratigraphy out of modeling clay. Having the students tell their own rock stories would be useful in developing a sense of change with time and the spatial reasoning skills that are important in the Earth sciences. There is a lot of learning to be had in a simple bucket of gravel. Having to really look at the individual gravel pieces helps the students to recognize similarities and differences. Sorting and categorizing the different pieces of gravel leads naturally to students graphing their data; this would be a good way to integrate math skills with science.

Yes, Earth Science is not only important for K-12 education, it is critical. After all, these children are going to be stewards for our Earth. Giving them the basic skills for evaluating Earth surface processes and Earth systems will be invaluable for navigating our increasingly crowded, resource-limited world. We, as a society, need to

understand and value that all of our materials and resources come from the Earth, and to build this understanding we need skilled teachers.

Jennifer Lepper grew up in Baltimore Maryland and got her biology degree from Towson University. She took a turn into geology and soil science with a Master's degree from The Ohio State University, studying clay and iron oxide in soils. Now, her true passion is playing classical guitar!

Use It or Lose It

by

Wade Gavin

For generations, science has been taught as if it were a trivial pursuit. Even if most students did fill in the correct bubble defining stratigraphy or geochemical evolution, their K-12 earth science education would be in a "woeful state" if they had not also acquired the creative problem solving and critical thinking skills that -- unlike a glossary of scientific terms and techniques -- they'd find useful for

the rest of their lives, regardless of their choice of careers. After all: Use it or lose it.

Unless we want to go into teaching or win big on Jeopardy, most of us can afford to forget most of what we learned in school. Those glossaries, along with history's names and dates, and almost anything else that could wind up on a standardized test, might as well go out the window; it's not going to help us to make ends meet. It's certainly not as life-saving as washing our hands after going to the bathroom or looking both ways before crossing a street. This focus on the trivial has left little time to learn how to cooperate and to work things out for ourselves. It has left little time to develop the chops we'd need to avoid fooling ourselves and being fooled by others. For all I know, science education has been deliberately sabotaged until now. Only the helpless and the gullible would put up with those traditionally in charge of our schools and our governments.

That's why I'm excited about the NextGen science standards, which require teachers to provide more hands-on experiences with science and, most importantly, to challenge their students to make evidence-based

arguments. It's not hard to imagine students learning about erosion and deposition, or tackling some of the problems related to coastal and riverine development, while playing -- yes, playing -- in a sandbox/water table. The best teachers have always put science to use in fun and memorable ways, as opposed to pleasing dictatorial administrators and text book companies by sticking to the script. The new standards might discourage anyone from treating science, or demanding it to be treated, as if it were a trivial pursuit or an argument from authority.

Teaching students that the earth is indeed more than 6000 years old isn't nearly as dangerous to the worst elements in society as showing all students, not just the ones that will go on to careers in science, how to recognize bad arguments and groundless claims, and to always be on guard against them. Science classes are opportunities to provide future voters and jurors with baloney detection kits, and with the realization of science not as a set of "facts" to be handed down like commandments from on high but as a great tool to be shared and as a model for constructive argument and successful cooperation.

The critical thinking and creative problem solving needed for scientific work can also help us to make better use of the people skills and the three Rs that most of us come to rely on outside the classroom. To this end, any of the sciences would do. The science that 'clicks' with a particular student is the right vehicle to practice critical thinking and problem solving. But because it seems easier and more accessible, because it CAN be child's play, and because understanding the forces that continue to shape our planet is relevant to our future survival and well-being, good teachers and their students are sure to find earth science useful.

Wade Gavin has done the heavy-lifting in a warehouse, backed a bar, cleaned up biohazards, kept the traffic from backing up, found lost personnel files and destroyed them, thrown pumpkins, and even sat on babies for a living. The public library has always been one of his favorite places; that's where he discovered CSICOP and popular science writers like Carl Sagan.

Seed Thesis for Earth Science in Public Education

by Russ Colson

Every now and then I like to get in a good rant. My colleagues rather enjoy pulling my rant trigger, and they know how to do it. One of my favorite rants is on the woeful state of K-12 Earth Science Education in the US.

What do I mean by woeful? Almost no schools in my state of Minnesota offer high school geology and less than 5% of students arriving in my college classes have had a single high school Earth Science class. My state is not an anomaly. In one national survey some years back, only 37% of *teachers* of geology had more than three traditional college geology classes under their belts—a rate of preparation worse than *any other discipline* by nearly a factor of two. More recent reports indicate that although enrollments in physical sciences have grown over the past 2-3 decades, and life sciences have maintained their high 90% rate, earth science enrollments have stagnated below 25%.

Biology faculty worry when incoming students don't know about cell organelles or understand the complexity of

organismal life. In twenty years of teaching college, I have never had an incoming student have any exposure whatsoever to key ideas of geology such as stratigraphy or geochemical evolution. Most of them think that geology is about naming rocks or testing mineral hardness, not reading Earth's stories.

As a society, we don't even know what geology is.

It wasn't always this way. Back in the 1800s, geology was the cool science. Many of the great scientists of the day gathered monthly for dinner meetings and discussion, a gathering that went on to become the Geological Society of London. Geology had big wins when field observations implied an ancient Earth despite calculations by physicists that the Earth was a young 20 million years old (yes, twenty million years was way too young to explain the observations). Today, popular thought gives Charles Darwin credit for discovering that life changes--but he didn't really discover that. Geologists had already figured it out by the time Darwin came along. In fact, Darwin's big contribution—understanding what governs that change—was of interest precisely because geologists had already discovered the immense changes in life through time.

In 1996, and again in 2013, US National Science Standards called for teaching all three branches of science: Life,

Physical, and Earth/Space. These national calls have scarcely moved the needle. Life and physical sciences are too entrenched and enjoy the reputation of being "what the college entrance requirements demand". One biology teacher explained to me, without even a touch of irony, "How can we offer a geology class when we can't even staff our fourth and fifth biology electives?"

Principals tell me they just can't find qualified earth science teachers, even though universities like mine will produce the teachers when there is demand. College faculty tell me that we just have to offer what the public wants, and it isn't geology.

And so, I rant.

My challenge to you is this: Please prove me wrong! Tell me the uplifting tales of how students' eyes light up when they see that classroom earth science addresses the world of their experience--what makes a cloud form, or how we can read the stories of deep time in the very bones of the Earth! Give me examples of communities where natural resource needs, climate, environment, and knowing our planet's past have called schools to enhance their preparation in Earth Science for all students. Tell me of the programs that make the integrative and multi-disciplinary Earth Sciences the capstone experience of their college-bound curricula.

Tell me, and give me hope for the future!

Dr. C.

Credit: Photo by Russ Colson

Find more essays and stories at Issues in Earth Science.