2008 AAAS/Subaru Essay Writing Competition for K-12 Educators, Finalist Essay

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Teaching Phylogeny with the Great Halloween Faunal Assemblage

My conversion experience that led to the non-traditional, interdisciplinary teaching methods I use today—which are based on the presentation of advanced science concepts and authentic materials in the earliest grades to make science accessible and engaging—was sparked by a single question: "Do we have bats in Minnesota?" It occurred on Halloween in 2001, just after I read the book *Stella Luna* by Janell Cannon to an arc of first graders arrayed cross-legged on the floor before me in an inner-city, public school in St. Paul, Minnesota.

I called on the boy who had groaned earlier about having to suffer the deadly combination of Book Look and Science on the high holiday of childhood, Halloween. To my surprise, his arm shot up and out and was now waving frantically before me, a stripy, biotic exclamation point.

"So, do we have bats in Minnesota?" I repeated, scanning the class slowly. Then I gave him the nod.

"Sure!" he beamed, eyeing his classmates archly with the smug confidence born of the correct answer. "We got witches, don't we? So we must have bats!"

Details aside, his answer presented a searing insight into ecological thinking about biological relationships. Realizing this changed the day's lesson plan. From morning Book Look at 8:30 a.m. with *Stella Luna* to dismissal at 2:30 p.m., we studied the ecology of Halloween. We were able to immerse and explore science for a full day because we were engaged and motivated by the connections that the putative bat/witch relationship called forth. So motivated were we, in fact, that we took on the entire Halloween faunal assemblage that day—in phylogenetic order.

We began with that venerable Halloween taxon: Slimy and Creepy. We dipped into invertebrates to cover worms and spiders. Then we jumped up to 500 million years BP to hit the hagfish and its tremendous mucous production abilities. Next we reveled in the riveting discovery of the marvelous lobe-finned coelacanth, allowing me to highlight the pluck and initiative of an early scientific female investigator, Marjorie Courtenay-Latimer. Newts came next. Then it was on to toads, warts and all. This led to an eclectic discussion of brothers and friends with warts; transmission and removal of warts; an ontological question regarding the role of the wart in making a toad a toad. Sample query: "Like, is a toad a frog with warts?" This was a nice transition to wood frogs' ability to freeze in winter and revive in spring, thus nicely covering the compulsory Halloween zombie theme. Returning to our evolutionary march, we picked up at Aves with ravens and crows— "clever corvids"— the standard bearers of the black Halloween motif. No corvidae kindred, the Blue Jays, need apply on this day. Entering mammals, we skipped the monotremes to save the platypus and echidna for spring, when a word or two about proper egg-laying mammals would provide welcome zoological clarity to the curious public portrayal of lagomorphs as egg layers, when in fact, they are placental mammals.

By morning's end, our tour of evolution brought us to whales for aquatic mammals, and a rousing chorus of "Baby Beluga"—preschool anthem, it seems—ended the morning. At recess after lunch, we played Whales and Sharks—a variation of the tagging game, "Ships Across the Ocean"—for kinesthetic reinforcement of taxonomic integrity: whales are mammals and sharks are fish. Back in the classroom, we cooled down with flying mammals, including all eight species of Minnesota bats.

We wrapped up the great Halloween faunal assemblage with terrestrial mammals: dentists. Dentists are intimately associated with Halloween, I instructed the class, in their role as stewards of dentition in modern American carbohydrate culture. We discussed deciduous teeth and deciduous trees; we strenuously resisted the class urge to veer onto the topic of tooth fairies and frank displays of wiggly teeth. With effort, we returned to the instructional point: dentition is the mammalian trait most affected by contemporary Halloween celebrations that create habitat for bacteria—which in turn cause dental caries. Ah! We had returned to the topic of ecological relationships.

Thanks to a creative context—Halloween—and a student's unwitting interest in faunal assemblages, I was able to give these first graders the greatest hits of my years of graduate school studies for two master's degrees, one in zoology and one in environmental sciences. I translated for them the big ideas—not the nuanced details of argument and evidence—of compelling science stories. And I told them all in a decidedly atypical, non-traditional way. It was a pedagogical panoply—a loud, busy mix of words, song, pictures, collaging, drawing, graphing and mapping, active learning, and post-card writing to the Minnesota Department of Resources Non-game Wildlife Program to thank them for protecting bat maternal colonies in Minnesota.

In the process of doing this over the years, I have discovered this approach enhances students' understanding of biological kinship relationships, attitudes toward science as a discipline, and enthusiasm for scientific inquiry as a fun, collegial, and important activity. Not only does science become fun this way, it does so in a non-trivial way. This is a key point. Trivialization of content degrades authenticity—and it is the very authenticity of science to which children respond. With authentic science, the great power imbalance that is the defining trait of childhood—small children live under the rustling canopy of adults ceaselessly whispering overhead, planning their lives—is righted. Children come to know and own knowledge of the natural world that their adults often do not know or own.

The approach to early science education I am advocating is a critical "pre-framing" of science. The goal is to inculcate in all children from their first days in a formal learning system an expectation that they enjoy science, are intellectually suited for it, and can and will excel in it; that they naturally belong. Successful pre-framing obviates the need for "re-framing" in middle school when too many students detach from science, and instead, regard it as a specialized enclave for the few and the geeky. Not any more; not if I have my teaching way.

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Too often we squander the pre-framing opportunity. Instead, we degrade our youngest learners' curiosity with fatuously contrived purple monsters or other trivial amusements offered to their questing minds—minds that are asking real questions, not to be plugged with dreg. My point is this: children are ready for so much more science so much earlier than we typically give them in early schooling. Anyone who doubts this has only to engage the average American five-year-old on the topic of dinosaurs and be astounded at the anatomic subtleties they have absorbed, their ability to relate form to function, and to think ecologically. What the doubters will see is that children are natural taxonomists.

We adults are the problem; we're the ones who have stopped sorting and analyzing. We too often fail our children in two ways. First, most of us are laggard students at sorting to species level, or at thinking taxonomically or systematically or critically. Second, we fail to affirm children in this marvel of early cognition—to acknowledge it, feed it, and extend it. When they show this talent for taxonomy and managing minute detail—ever parse the world mythologies of Lego back-stories?!—we don't help them make the connection that they have, in fact, joined the Great Quest, and are able practitioners of the craft of thinking critically about phenomena, detecting patterns and relationships. They are scientists.

Let me be clear. I am not asserting that while first graders enjoy exposure to high-school or college-level concepts about natural history, they can take the same tests to demonstrate mastery of concepts we would expect of older students. They can't. But that's not the point. I am not conceptualizing early science education as a mass balance equation performed over the school year, where Input = Output. Rather, I am offering a pre-framing model as a process of building imaginative infrastructure to support complex learning over time. The goal: when students reach higher grades, those who have been pre-framed to succeed in science do, in fact, succeed. I am practicing and urging early, accurate exposure to authentic scientific ideas and materials typically not offered until high school or college as a way of influencing the imaginative infrastructure children must build to manage 21st-century complexity. Waiting until upper elementary grades or middle school to get serious about robust science content is too late. First grade is where the genuine and steady science content stream must begin if we are to honor and develop the inborn capacity most young children have to become phylogeny prodigies—and succeed in sciences we have yet to imagine.