Central to envisioning what we want our schools to look like in 20 years is what we want our science instruction to look like. We live in a world of rapid change, and how schools adapt to this new landscape is a question of utmost relevance. Our collective impacts on land, water, biodiversity, and atmosphere accrue steadily, inching us toward undesirable outcomes with far-reaching consequences. At the same time, dangling in front of us are opportunities to get things right.

Science is a bridge that can link dynamic conditions to adaptive strategies, problems to solutions. Depending upon how we look at it, we might see these times as rich with possibilities for doing better.

How can we use our shifting environmental and cultural ground as an opportunity to teach science lessons that are real and relevant? We start by reexamining our notion of what education is for. Our science curricula should not just aim to develop in students a strong knowledge base; it should aim to develop and train people who — through their knowledge base and life skills — see themselves as participants in their communities and the world, and act accordingly.
Science and Social Justice

In its November/December 2013 issue, Orion magazine published Belle Boggs’s article “Putting the ‘I’ in Science.” Independent school students know what cells are, what they look like, how they replicate. They have engaging, lively, and often active demonstrations in their classrooms. So, where are the blind spots for committed independent schools aiming to cultivate scientifically literate citizens? One area is the bias in the language we use. Conventional training — one might even say fine training — in scientific writing encourages adherence to rule No. 1: Don’t use “I” when writing science reports. Such writing is to be objective rather than subjective. It is to be dispassionate, detached, fact-based, and reproducible. 

I get it. The rule is a foolproof way to avoid writing science reports like journal entries. It steers us away from opinions and long-winded expositions. It is what real scientists do. But in school, an over-reliance on the passive voice — on asking students to pretend that who they are doesn’t matter in their research — has the undesirable effect of disconnecting science from unintended consequences of these chemicals. His team from the Warner Babcock Institute of Green Chemistry went on to describe a strange aspect of chemistry: the relationship between a molecule’s function and toxicity is not linear nor necessarily predictable. For example, changes in the location or orientation of a molecular branch in a dye might make it more durable against fading in the sun while completely ramping up — or down — its toxicity.

Warner’s point is that our scientific language may contribute to dissociating the human from the process in which he or she participates. Removing “I” in the language of the “Materials and Methods” sections of a science paper removes accountability. We are trained to say “5 grams of X was mixed with 5 grams of Y,” and we may come to believe, as we have written, that the chemicals actually mix themselves. Pair this disassociation with a lack of training in toxicology and chemical engineers might become players in a high-stakes system without checks and balances.

The “no I” rule certainly has its time and place — for example, when students aim to become narrators of a sequential tale involving scientific laws that do not bend to opinions or wishes. Know what formula you’re using. Plug and chug. Produce an answer. There is no debate. School-taught science must retain its signature objectivity. Students must also teach science so that the student is a part of the process he or she is exploring, certainly as an observer, and, when possible, as a player, too. In other words, science must be relevant — and perceived as such — to students’ lives.

To this end, we need to think of “I” in two ways: literally and metaphorically. Literally, it can mean putting the first person and active voice back into our science writing. metaphorically, there are ways to put “I” into what we do with science, to integrate our students into the education process he or she is exploring, thus returning us to the promise of this article: to teach science in a way that inspires better citizens.

We need to think of “I” in two ways: literally and metaphorically. Literally, it can mean putting the first person and active voice back into our science writing — for example, as the mixer of the chemicals (“I mixed 5 grams of X with 5 grams of Y”) or as the narrator whose paper tells a story that engages the reader while retaining objectivity and aiming for outcomes that are not predetermined. 

UC Santa Barbara Professor of Geology Josh Schimel asserts in his book Writing for Science: “I believe every single scientist has a story to tell, and I believe that story is the only way to get people interested in science. Scientists have a natural bent to understanding cause and effect, to explaining outcomes. Thus, every scientist owns that data — it also interprets the text, ‘I’ is very much in the paper metaphorically. Literally, it can mean putting the first person and active voice back into our science writing — for example, as the mixer of the chemicals (‘I mixed 5 grams of X with 5 grams of Y’), or as the narrator whose paper tells a story that engages the reader while retaining objectivity and aiming for outcomes that are not predetermined. When they don’t, we need to think of ‘I’ in two ways: literally and metaphorically. Literally, it can mean putting the first person and active voice back into our science writing — for example, as the mixer of the chemicals (‘I mixed 5 grams of X with 5 grams of Y’) or as the narrator whose paper tells a story that engages the reader while retaining objectivity and aiming for outcomes that are not predetermined. When they don’t, we need to think of ‘I’ in two ways: literally and metaphorically. Literally, it can mean putting the first person and active voice back into our science writing — for example, as the mixer of the chemicals (‘I mixed 5 grams of X with 5 grams of Y’) or as the narrator whose paper tells a story that engages the reader while retaining objectivity and aiming for outcomes that are not predetermined. When they don’t, we need to think of ‘I’ in two ways: literally and metaphorically. Literally, it can mean putting the first person and active voice back into our science writing — for example, as the mixer of the chemicals (‘I mixed 5 grams of X with 5 grams of Y’) or as the narrator whose paper tells a story that engages the reader while retaining objectivity and aiming for outcomes that are not predetermined.
Science-Based Experiential Education

Experiential education — for which relevance is the goal — offers a valuable approach to making science relevant to the lives of our students. The Experiential Learning Cycle, developed by David A. Kolb, a social psychologist at Case Western Reserve University, and shared by Jessie Barrie, the director of the Independent Schools Experiential Education Network (ISEEN), involves four steps in an iterative process, in which past learning informs future experience:

1) A concrete experience
2) Reflection on that experience (What happened?)
3) Abstract conceptualization of the experience (So what? What went wrong? What went right?)
4) Active experimentation (Now what? What is going to happen?)

Applying these steps to the teaching of science helps students of all ages see the ways in which science is directly connected to their lives — and to responsible citizenship.

Tied to our basic needs: water, food, and energy. The outcome of these studies must be more than science-based awareness of problems. We must instill not only a heightened sense of how to navigate the problems with informed choices, votes, consumer habits, and the ability to contribute to solutions. We must put “I” into these major topics with all our students, from the iconic frustrated ones asking, “But what does this have to do with me?” to the Ivy-bound ones who can ace standardized tests and on whom we pin much of our hopes for a purposeful future.

Such experiential learning requires built-in time and guidance for all of its steps to play out (see sidebar on the left). To be delivered most effectively, it requires opportunities for meaningful participation in the world. Students must be able to do something as citizens, whether as scientists, builders, or activists. A tangible experience as a player — even a small one — is formative for adolescents.

Activism Starts Here

In the important book The Failure of Environmental Education (and How We Can Fix It), Charles Saylan and Daniel Blumstein advocate strongly for inter-disciplinary and active solutions to environmental problems. Social action is their most fervent and final point: “[E]ven the best possible curricula will not translate into action unless it includes a strong and relevant social component. Students must experience active involvement in a community where theoretical knowledge is practically applied and actions and reactions have personal significance and value to the individual and community alike.”

Key to active participation are exercises in school in which “students experience the process of making measurable impacts.”

In other words, our science curricula must provide a solid understanding of the environments in which we live while offering opportunities for students to be stakeholders and players. Real solutions are interdisciplinary. They involve critical thinking, economics, science, technology, math, politics, history, communication, artistic expression, writing and speaking, and the art of persuasion. Imagine the power that will reside in a well-educated population of 20-year-olds who have seen their work matter in high school, and who additionally start to sense what unique strengths they can bring to such work!

Midland’s tagline is “Live Your Education,” and Midland students see the outcome of their work chopping wood for heat, tending a 10-acre organic garden, and annually installing grid-tied solar arrays that cumulatively, after 10 years, meet 30 percent of campus electricity needs. Central to implementing these projects is direct student involvement alongside professional guides.

A key outcome is that we make the invisible visible to our students. This has been in Midland’s DNA since our founder, Paul Squibb, wrote that, “Money, light, heat, and water are not things that flow naturally out of pipes, but are things for which somebody has to spend time and thought and energy...I believe the [students who have learned to] take the material blessings of life for granted will live a more vivid and interesting life and will be the better citizen.”

Studying water, food, and energy — amid a landscape of daily immersion in the outdoors — are not “add-ons” at Midland; they are at the core of rigorous college preparation. They provide a spectacular backdrop for teaching science-based solutions to global problems. They are natural extensions of a school mission that values character, self-reliance, and the development of our inner resources through daily jobs.

Of course, many other schools have embraced science-based experiential education — from schools that run farm and garden programs to those that engage students in real-world research in which the results impact public policy. Two excellent examples are Albuquerque Academy (New Mexico) and Nichols School (New York). At Albuquerque Academy, students in Earth Systems Science (eighth grade) and Bio E (Biologically oriented Ecology Emphasis) are helping to create a...
new garden for the school and community. The Southwest is faced with the challenges of providing food with resources that are dwindling due to climate change and soil depletion. The New Desert Oasis Teaching Garden is designed to teach students and the local community how to grow food in a hotter, drier land using nature and the wisdom of ancestral peoples who have grown food in the region for hundreds of years. Since the garden’s inception, students have been involved in every step of the process, including using satellite imagery to measure the potential for harvesting water off the school’s science roof in order to size cisterns. Bio E students, meaning to measure the potential for harvesting water off the school’s science roof in order to size cisterns. Bio E students, mean-while, have been working on an independent project to teach their commu-nity about sustainable gardening.

At Nichols School, in Buffalo, seventh-grade science teacher Sandy Cunningham engages her students in the study of local water resources, working with the Environmental Protection Agency and a number of non-governmental organizations, including Buffalo Niagara Riverkeeper and Trout Unlimited. After learning about the biosphere and the distribution of water resources, the students focus on the Great Lakes — studying the hydrology, nutrient and water movement, the food webs, invasive species, and water quality issues in each lake. They also focus on Buffalo’s Scajaquada Creek, investigating the history of the area around the creek and the creek itself. The students eventually engage in a three-part investigation of the waterway: mapping and evaluating land uses, riverbank evaluation and erosion potential, and a chemical analysis of the water.

Where will schools be in 20 years? It’s hard to say. But we know we live and work and teach in pivotal times. We know, in particular, that we are rapidly drawing down our natural resources as our population rapidly increases. We know that the pressures we’ve put on the planet are not only altering the climate but also are doing serious damage to the planet’s biodiversity. And we know that our system of formal education is central in addressing and ameliorating these and related issues. Whatever else we may do in school, we’d be wise to connect the teaching of science to citizenship.

Where will we begin in choosing science topics to educate citizens? The number and range of issues are staggering: climate change, renewable and nonrenewable energy, ecology, farming, health, water quality and rights, public vs. private ownership of resources, economics, life-cycle analysis, full-cost accounting, externalities, and investing. But we don’t need to address them all — and run the risk of subjecting our students to issue fatigue and fear. Instilling in students John Dewey’s “attitude... of desire to keep on learning” and grounding them in the belief that what they do matters is more valuable than covering a great many topics. Give students a chance to experience a small win, and then another. Don’t just profess a litany of problems.

I find author and Oberlin professor David Orr to be a North Star pointing out our deepest needs in environmental education. Having read his books and heard him speak several times, I’m convinced he’s right in lamenting that college students do understand climate science, but they don’t think it’s their responsibility or that they can make a difference. In 2008, I heard Orr say, “I worry less about solvability than despair that will keep us from trying.”

The vitally important part about trying requires re-tooling student habits away from being spectators and toward being players. This must begin long before college. It matters what we do and it matters that we do. Perhaps it can start with putting “I” back into our study of science — and see where it leads us.

Liz Goldard is director of environmental programs and curriculum at Midland School (California). Founded in 1932, Midland was recognized with a Governor’s Award for Environmental and Economic Leadership (California’s highest environmental honor) and a Santa Barbara County Green Award. Its course “Water: California’s Liquid Gold” was named one of AdmissionsQuest’s “Five Schools with the Coolest Classes.”

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