Introducing Young Citizens to Science and Mathematics

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One must applaud Dennis Lomas's essay on several counts. The modesty of his title is appealing, especially since he addresses a question that many would consider among the most serious in curriculum theory: from what philosophical perspective do we introduce science and mathematics into the curriculum? And, praise the Lord, he came up with the right answer: "critical realism."

Lomas identifies an opposition that he calls "extreme relativism" (*ER*), defined as a doctrine which "holds that *no* proposition from mathematics and science is...true independent of our thinking — either individually or collectively — that it is true." Lomas then presents us with an essay that attempts by various moves to refute *ER*, at least as it applies to introductory classes in science and mathematics. Fortunately for our cause, Lomas's refutations are moot, since *ER* refutes itself. The real threat to critical realism lies closer to home, as we shall see.

In brief, to deal with *ER* simply state it in a form reducible to canonical notation. For example: Let *P* be any proposition from mathematics or science. Let it be false that there is somebody, anybody, *S*, such that *S* thinks — either individually or collectively — that *P* is true. It follows, according to *ER*, that *P* is not true, that is, P is false or worse yet, that P has no truth value, that is, is not a proposition after all.

Poor lonesome, un-bethought *P*! Now Lomas is no doubt using "think" to mean the dispositional "belief" rather than the episodic "think," as in "What are you thinking at the moment?" (Imagine a universe where truth values bounce on and off as people, individually or collectively, happen to think about or not think about individual propositions!) Even so, it is ordinarily considered a successful *reductio ad absurdum* to show that a philosophical stance reduces to the formula in which *ER* is defined. For the next move is checkmate. Let *P* = the 5,259th digit in the decimal expansion of *pi* specifies a prime number. No one had ever thought that *P* was true (or false) before I just wrote it. Did it just gain a truth value? Or did that occur only after I had considered the odds and marked it "probably true?" Thus, if *ER* is not literally incoherent, it is patently absurd. Lomas says that certain influential people talk that way, and some of his quotes seem to carry that ring. If they actually hold to the formula by which he defines them, then they represent a lunatic fringe and may be ignored henceforth. Beyond, beneath, behind them lies a threat to critical realism more serious than silly little *ER*. To reveal it, may I tell a story?

From Nature Studies to Science

Once upon a time inside the W.H. Kilpatrick School (W.H.K.), the science faculty had been long engaged in bitter debate over the question posed by Lomas. Today the entire faculty is gathered to hear the opposing causes. At W.H.K. such curriculum decisions are not made by politicians or political appointees but by the faculty as a whole, assisted by experts from university faculties, in this case, of course, members of the Philosophy of Education Society.

The Chairperson of Science has reminded his W.H.K. colleagues of the heavy emphasis given science throughout the k-12 school experience. From their earliest years, students at W.H.K. have spent a big part of their time in carefully conducted, cooperative study of the material world around them. They have caught and weighed frogs from ponds, played number games ("How can four sevens equal 100?"), maybe took part in the birthing of lambs. In nature study they have learned not only about nature but also about how people are organized rationally to study nature, tying into social studies and literature. And thus prepared, students enter their sixth school year, there to be introduced to general science. How is that transition to be presented? Opinions are divided.

The dominant faction among the Science Faculty at W.H.K., led by Sam, favor the gentle approach. Sam's time is almost up:

> Let me conclude my case with an anecdote from yesterday's class. The kids were busy tabulating the vital statistics of a bunch of butterflies they'd caught that morning when I rang my little gong to get their attention. "Well," I said, "look here, young citizens, right about now we find ourselves studying not just the meadow out there but lepidopterology, a branch of zoology, which is a branch of biology, which is a branch of science. So now we're studying science, what do you think of that?"
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> And Joanna Cantore, a new student from public school, responded first, "I thought science was supposed to be hard and boring, but what we've been doing was, well, kinda hard work out there and all, but fun and interestin' too."

That is how science should be introduced to the curriculum, just as standard curriculum theory always reminds us: continuity, no abrupt breaks. And Sam goes on to remind the youngsters of how they have learned to classify, to smell, feel, touch, describe, to measure, to count. Science is just putting all those things together. And I explain how science is merely one among many ways that different human groups have figured out to talk about the real world and create knowledge of it. The basis of all knowledge, I tell them, is the kind of knowing you gained when you felt a butterfly's wing between your fingertips this morning. We teach what we call science because it has proved our most useful way to organize and communicate real knowledge. It is heartbreakingly sad to have to make you understand, but understand you must: while the scientific way of organizing human knowledge has made possible extraordinary achievements to advance human welfare, it has also been the most powerful weapon the powerful possess in their oppression of human beings and destruction of the human habitat. Your generation must change that. We must dethrone almighty "Science" from its perch at the top of human knowledge in order that it may become an effective servant of human welfare in an integrated world.

One hears in Sam's rhetoric the emancipatory note that Lomas mentions finding among opponents of realism. And one does not hear any absurdity like ER. It is easy to see why Sam's should be the dominant faction at WHK, and why he received, by academic standards, a hearty ovation.

The minority caucus chose Isabel as spokesperson. Her diffidence was evident, no less so her sincerity.

> If these were ordinary times, and a pedagogy that successfully inducted youngsters into a stable, ongoing social process were a pedagogy adequate to the times, then we would stand

> four-square with Sam. But such is not the case today. The international community of science, every discipline represented, recognizes that our present, unstable political systems will not, cannot, evolve through their own internal dynamics and create a world where human beings live in peace among themselves and at peace with our fellow material objects. Sam is correct to insist that the present employment of science to advance the causes of war and oppression is wrong, needs to be changed, and poses an obligation on WHK graduates to enlist in the struggle. But his approach to science deprives the progressive cause of our strongest pedagogical move to bring them to revolutionary consciousness.
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> When we undertake to move from nature studies to science, we move, as Sam said, to a specialized way of organizing and talking about knowledge gained from direct encounter with natural objects. This way of science is called our theory of the world. We are no longer teaching facts about nature; we are teaching our theory of it. And the students must first of all come to know what a theory is, how the whole edifice of scientific theory is linguistic. They understand that we call it "our theory" of the world because it translates literally among all natural languages. Science, the lingua franca of our common humanity, presents a picture of the world that poses a magnificent opportunity and moral burden upon our graduates and thus upon us.

Isabel's voice grew stronger as she spoke of the great peril that science sees ahead for the enlightenment and its legacy, together with the great gains in human knowledge and self-fulfillment we have made, all tied into the special duty that the scientific view of the world imposes on our American democracy. Four minutes were enough to establish her point, then,

> Our only salvation, if we have one, will be a generation of Americans who have learned to listen to the voice of reason in their lives and in their politics. We do have hope that reason may be awakened in the minds of these young animals, minds, even among our protected clientele, already badly polluted by the poison of consumerism. We have hope because we have truth on our side. And we would begin with instilling a clear meaning and fundamental moral respect for truth in our students. We will have them learn as a catechism, long before they understand more than a smattering of it:What is Truth? In the beginning was the sentence, and "Truth" is an abstract noun that designates the set of all true sentences. How does a sentence become a member of that set? A sentence is true if and only if the world, whatever it is about the world that the sentence refers to, does what the sentence says it does. How do you know whether the world as referred to does what the sentence says it does? That is a question of method: precise definition of terms, care in observation, and application of the skills and habits you learned in nature studies. How do you achieve adequate precision in definitions? Define your terms as "Truth" was defined above. What must be the case in the world-referred-to for the sentence to be true? If that can be clearly pictured, the terms of the sentence are adequately defined.

Isabel could feel her audience withdrawing, interrupting her catechism with its questions and answers on "reality," "knowledge," and "belief." She jumped ahead to justify putting first-order quantification theory as the initial substantive element in the science curriculum. It is hard, boring, and requires the utmost in peer teaching (of the sort WHK students are already adept). But to the logic she added a dazzling video presentation of the cosmos as successively envisioned by different human cultures, all shown to be timid and earthbound compared to what our theory of the world reveals. Our curriculum, Isabel argued, should provide a specific remedy for superstition and mental laziness, as well as a training ground students who will quietly, gently, but firmly assert the epistemological supremacy of our theory of the world wherever the question of true or false arises; and just as firmly assert its ever-changing, growing nature, sovereignty in process, falliblility in every detail. She concluded,

> And our students will demand that all those who profess some other Truth must provide sentences to be tested, not feelings to be appraised. To be true is to be true, or probably true to specified degree, in our theory of the world, "our" referring to the entire species. Here is the mode of thought that ties us to all humanity and to reality as a whole. This is where our students want to stand.

When Isabel concluded and returned to her seat she faced startled silence, broken only when Sam stood and applauded. The sound was echoed here and there as the elected president of the faculty banged a gavel and declared a twenty minute recess.

The moral of this story for Lomas is: Do not try to refute those who would question, say, "perceptual justification of belief," what an unappealing trio of abstractions that is. Simply overrun 'em. Our theory of the world asks to be read literally, "there is some x such that" affirms an independent reality. But it is also true in its epistemological foundations that no necessity binds our theory of the world to the world referred to; that tie is purely pragmatic, relative to the senses we possess as a species and relative to a multitude of historical accidents and human needs and talents. We are all realists; we are all relativists. The question is, who has something to say to teachers that will arouse their most progressive instincts.

P.S. The faculty at W.H.K. voted to allow Sam and his supporters to teach introductory science as they chose, likewise Isabel and her colleagues. In the beginning, student choice almost closed Isabel and company's classes, but lately her group's sections have been growing steadily. Is a new generation emerging?