

LETTERS

Physics First: Of Insight, Pool Balls, Stasis, and the Scientist in the Crib

The lab-based “Everyday Physics” course that I often teach at the University of Michigan provides an initial encounter with physics for seniors who will soon disperse throughout society. But basic physics concepts and the inquiry-based learning environment should be experienced a decade earlier in the lives of a much wider sphere of students, as Leon Lederman so persuasively explained in his Reference Frame (PHYSICS TODAY, September 2001, page 11). Switching to the more natural “put physics first” learning sequence will help to instill crucial dynamics into the lifelong learning process for students and teachers alike.

Much is already known about the student dynamics of inquiry-based physics activities. But which of these dynamics should be nurtured in children prior to their tackling ninth-grade physics? Doesn't lower mathematics itself unfold through dynamic learning processes? Surely there are countless Aha! moments that propel playful creativity in young children, and the incessant questioning process is a central dynamic that drives their learning. Why aren't school children specifically taught to better focus on their own internal thinking processes? Such a focus could make the learning experience more natural and enjoyable for all.

Perhaps, once an inquiry-based physics-first curriculum becomes firmly established in our school systems, a further push toward instilling an even earlier (or parallel) program of appropriating the knowing process itself should be contemplated. Although we have impressively developed inquiry-based physics, problems remain in distilling the full dynamics of understanding and knowledge growth. Now

seems to be the proper time for us physicists to reflect anew on our own internal processes so that we can better clarify our full education message to the nation's schools. The standard scientific method, for example, seems more like a prescription for doing science than for revealing how we actually work and think. And the dynamics can become murky when “commonsense” thinking (whatever that is) weaves back into the purely scientific discovery process.

I recently came upon a perceptive and applicable heuristic model of knowledge growth presented in Bernard J. F. Lonergan's *Insight: A Study of Human Understanding*.¹ This work, written in 1957, speaks directly and persuasively to physicists, other scientists, and sound thinkers everywhere. Lonergan's thrust “is not the known but the knowing. The known is extensive, but the knowing is a recurrent structure that can be investigated in a series of strategically chosen instances.”²

Starting with the expectation of intelligibility, the pure desire to know, and a redefinition of insight as the Aha! moment, Lonergan models the inquiry process—from wondering, observing, and questioning, to finding a clue and then supposing, conceptualizing, and imagining. Quite suddenly, insight happens. A release from tension follows, along with the further dynamics of concept building, reflection, related insights, verification, and eventually judgment, whereby new understanding becomes explanatory knowledge. After a detailed exposition of these and other dynamic traits (including horizon growth, statistical thinking, and revisability), Lonergan characterizes commonsense thinking and its biases. He then models knowledge growth and development as a complex genetic framework of recurrent schemes, upon which he builds a critical realist philosophy.

Lonergan's treatise clarifies the dynamics surrounding inquiry and explanatory knowledge growth, and so provides a firm basis for grasping the overall unity inherent among the various academic disciplines. Therefore, *Insight* is pertinent to Leder-

man's rational “once in a hundred years or so” curriculum redesign.

References

1. B. J. F. Lonergan, in *Collected Works of Bernard Lonergan*, vol. 3, F. E. Crowe, R. M. Doran, eds., U. of Toronto Press for Lonergan (1992).
2. See ref. 1, p. 12.

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The proposal by Leon Lederman to teach physics in the 9th grade, chemistry in the 10th grade, and biology in the 11th grade is interesting, but his justification is unconvincing.

Most physics courses cover classical mechanics before electricity and magnetism, and most students I have spoken to attest to finding the concepts of electricity and magnetism hard to grasp because they involve unfamiliar phenomena. The collision of two pool balls is within the realm of many adolescents' experiences; the buildup of charge on a capacitor is not. To give an extreme example, it would be absurd to teach general relativity before Newton's theory of gravity, even though the latter is less fundamental than—indeed is a special case of—the former. Learning should probably parallel the history of scientific discovery, with familiar phenomena studied and understood at least superficially before general theories are developed to explain higher-level phenomena.

The ideal approach, I believe, is to teach biology, chemistry, and physics simultaneously, as is done in Europe. Only the time-honored tradition of the fixed daily schedule really stands in the way of this arrangement. Carefully constructed curricula that offer two or three class periods per week of each subject would enable the connections between the disciplines to unfold at the appropriate times while allowing exploration of familiar scientific concepts before general theories. Concepts could then be revisited in the light of the theories.

To return to the gravity example,
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