Toward Rational Education Policy

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In his recent State of the Union message, President Bush called upon the United States to bolster mathematics and science education as a means of nurturing corporate innovation. With his plea, he lent urgency to a complex and multifaceted debate over how best to achieve such improvements. That debate—currently raging among academics in fields as dissimilar as cognitive psychology, social change theory, and education research (1–4)—is the controversy that Michael Feuer refers to in Moderating the Debate.

The author developed this small, highly readable book from the 2004–05 Burton and Inglis Lectures that he delivered at the Harvard Graduate School of Education. Feuer, a leading education research and policy analyst and executive director of the Division of Behavioral and Social Sciences and Education at the U.S. National Research Council, focuses on “a mysterious gap in applied social science.” Cognitive psychology, he notes, has been central to modern theories of teaching and learning. Indeed, many of the interesting reforms currently being applied in the teaching of reading, mathematics, history, and science are motivated largely by recent cognitive research findings on how people integrate new information with their prior knowledge, how they solve problems, and how they mix learning and memory with discovery and invention (5).

Feuer argues forcefully that education policy—including theories of school organization and reform as well as strategies for relevant and useful education research—should benefit from advances in cognitive science. “It is something of a mystery...,” he notes, “that the cognitive revolution has barely touched education policy and the organization of schooling.” Given the success of the cognitive revolution as, on the one hand, a tool for understanding human learning and, on the other, for offering insights into organization theory as applied to such policy domains as antitrust law and labor markets, it seems only reasonable that lessons of cognitive psychology should also be applied to the theory and practice of education policy, “where decades of well-intentioned but unrealistic goals suggest the need for a new model of rationality.”

After reviewing the contributions of cognitive science to theories of human performance, learning, and assessment, Feuer describes a select few of the many recent developments in organization theory and policy analysis in domains other than education that derive from the cognitive view of rational decision-making. To explore how theories of organization, modified by new cognitive principles, might shed light on critical issues in the education debate, the author (trained as an economist) takes the reader through a “brief digression” to review neo-classical and cognitive economic models. Building on Herbert Simon’s notion of “procedural rationality” (6), Feuer’s analysis of major education policy and reform efforts of the latter half of the 20th century focuses on organizational complexities and the implicit cognitive demands these complexities impose on educators and policy-makers. He emphasizes the view that rational decision-making is a function both of the mental and technological resources available to the decision-makers and of the objective complexity of the decision problem to be solved. Education policy—including the current hot debates (4) over standards of evidence, research methodologies, and how to define “scientific” research in education—would be fertile ground for a cognitively inspired theory of action, by which Feuer means “a framework that connects observation to prediction and lays a foundation for reasonable program and policy goals.” Such a theory, he believes, would apply principles of cognitive science and procedural rationality to develop reasonable and realistic school reform strategies.

An important element of Feuer’s argument about procedural rationality, which he fears may seem counterintuitive, is that “science is furthered, not hindered, by the acknowledgment of complexity and the admission of bounded human problem-solving capacity.” Scientific inquiry into questions as complex as those underlying problems of education policy and research methods must be understood to require an incremental process of knowledge accumulation involving the combination of multiple types of data, rather than a single method that promises definitive answers to well-defined causal questions. Procedural rationality, to the author, means something like pragmatism, or “doing the smartest thing possible under the very real constraints of time, resources, and context.”

References and Notes

CT Scans vs. X-rays

Marjorie Senechal

In addition to untwisting a knot in a cord whose ends were sealed together without touching the cord itself, [the 19th-century American spiritualist Henry] Slade claimed to have joined solid wooden rings together, transported objects out of closed containers, and written on pages tightly pressed between two slates—all supposedly under scientific conditions.” In an entertaining early chapter of Shadows of Reality, Tony

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1979–8. Robbin used multiple perspectives in this painting (acrylic on canvas, 1978) to place the viewer in several positions at once as a depiction of hyperspace.

Robbin discusses Slade’s 1876 trial for fraud in London. Physicists argued that such feats could be explained by access to an extraspatial dimension, and the trial “did little to dampen enthusiasm for the spiritualism of the fourth dimension.” Yet 19th-century explorers of the then-arcane fourth dimension bequeathed to us a toolkit for imagining and imaging, inter alia, the hypercube, the cross-polytope, and the pentatope.

The principal tools are slices and shadows (1). We can, like A. Square in Flatland (2), train our mind’s eye to “see” four-dimensional objects as stacks of lower dimensional cross sections. Or we can study their projected images (in our three-dimensional space) and imagine lifting them back whence they came. Thanks to these tools and to 20th-century revolutions in thought (the physics of spacetime) and technology (modern computer graphics), the fourth dimension is no longer a spirit abode, accessible only to magicians and mediums. Physicists can’t do without it. Mathematicians have tamed its geometry. Artists, including Robbin, delight in exploring it. Hyperspace has become respectable, even conventional.

Shadows of Reality is a fascinating fly-through of the diverse, intellectually rigorous climes in which Robbin finds tracks and traces of hyperspace. Impressed by the power of x-rays to reveal heretofore unlimpsed reality, he tells us, Picasso studied four-dimensional geometry and used it in his 1910 painting Seated Woman with a Book “to show his audience the reality they knew existed but could not otherwise see.” Hermann Minkowski’s formulation of space-time transformed four-dimensional geometry from an idea into truth. Quasicrystals—which Robbin identifies with Penrose tilings—can be derived by projection from four-dimensional space. The intrepid author even tackles Roger Penrose’s twistor theory, quantum entanglement, and category theory. The book is a persuasive case for restoring geometry to its once-hallowed place among the liberal arts.

Unfortunately, that is not the case Robbin is trying to make. Shadows of Reality is a polemic on behalf of one visualization method and against the other: shadows over slices. According to Robbin, the slicing model, promulgated in Flatland, gets all the credit, while the projection model does all the work. “Consider this book a modest proposal to rid our thinking of the slicing model of four-dimensional figures and spacetime in favor of the projection model,” he writes, adding that “the proposal means developing a distaste for the slicing model…. It’s hard to tell whether he really believes this—if his doctor orders a CT scan, would he demand an x-ray instead?—or whether he’s trying to spice up a book he fears might otherwise be bland. If he does believe it, I fail to understand why. The projection model has received more than equal time for the past 60 years, thanks to the unstinting efforts and ever-widening influence of the great, late geometer H. S. M. Coxeter and his classic Regular Polytopes (3). In any case, why privilege either of these two invaluable and complementary methods over the other? Most of us poor three-dimensional creatures need all the help we can get.

Robbin’s zeal sometimes leads him astray. For example, in the chapter “Patterns, Crystals, and Projections” he briefly considers three methods for generating Penrose tilings: matching the tiles together in accordance with specified rules; cutting the tiles into smaller tiles and then inflating them, ad infinitum, to construct a tiling that repeats on all scales; and projection from a periodic tiling of a higher dimension (four or five) onto a plane. Each of these methods tells us things about Penrose tilings (and many other nonperiodic tilings) that the others do not. All three are powerful and fruitful tools in the study of aperiodic order. Yet Robbin dismisses the first on specious grounds and the second as “of limited use.” “It is now understood,” he asserts, that N. G. de Bruijn’s projection method “is the most general, informative, and foolproof of the three.” (By the way, the projection method is a two-step operation: first slice, then project that—so it is also known as “cut and project.”)

Robbin is, of course, entitled to his opinions. And let’s not quibble over details. Any author of such a bold interdisciplinary adventure is likely to get some details wrong, and he is no exception. (Still, one wishes some of the more egregious had been caught at the proof stage.) The panorama he sketches in Shadows of Reality is rich and fascinating. Enjoy the forest, just don’t look too closely at the trees.

References and Notes
1. In some special cases, we can also imagine a four-dimensional object as a three-dimensional construction folded up. Thus the hypercube is often “drawn” as an array of six cubes, like the cross in Salvador Dali’s Crucifixion.
2. [E. A. Abbott], Flatland: A Romance of Many Dimensions (London, 1884); see www.alcyone.com/max/lit/flatland.
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