Carnegie Perspectives
A different way to think about teaching and learning

Throwing out the Baby with the Bath Water

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Abstract: A reminder that the polemics of reform frequently portray the realm of teaching and learning in far more extreme terms than is really necessary.

Essay:
In his classic *The Structure of Scientific Revolutions*, physicist Thomas Kuhn argued that scientific revolutions are characterized by a completely new world view that is incompatible with what it replaced. In this sense, scientific revolutions are non-cumulative; rather than build on what has gone before, they jettison completely the assumptions and premises of the theories they replace. Darwin's theory of evolution did not tweak the prevailing notion of a static, instantaneously created natural world not essentially different from what we see today. *The Origin of Species* threw out the notion entirely and replaced it with a living world evolving over eons of time through natural selection. The heliocentric structure of the solar system proposed by Copernicus (and refined by Kepler and Newton) did not build on Ptolemy's elaborate geocentric model; it dismissed it out of hand, and in so doing changed forever the way we view our place in the universe.

On a less lofty scale, educational reforms often propose similarly radical new world views. In its original incarnation, the "whole language" movement in reading instruction dismissed "phonics" as a misguided way to introduce young learners to the written word. It was argued that children should be immersed in actual text with associated visuals and discussion. The ability to spell and read with understanding would come in due time. The "new math" reform of the 1960s rejected practice and drill on the "times tables" as a mindless activity that turned young learners off from mathematics. Tom Lehrer, the professional mathematician turned occasional cabaret performer, summed up the entire approach with his quip that the important idea underlying new math is "to understand what you are doing, rather than to get the right answer."

"Traditionalists" were deeply skeptical of these reforms, and with good reason; many of the innovations were based on faulty premises. There was precious little hard-nosed, empirical evidence to buttress the exalted claims on behalf of the new approaches to instruction. Moreover, the vast majority of elementary school teachers were ill-prepared, especially in mathematics, to handle the innovations. The net result, if one believes the traditionalists, was a generation of young people, the majority of whom could neither spell, read, nor perform simple mathematical operations. And the reaction by the public, the press, and elected officials was predictable: a call across the nation during the 1970s and 1980s for "back to basics" instruction and a proliferation of minimum competency standards for promotion and high school graduation.

Over the past quarter century, cognitive scientists, working closely with teachers in actual classrooms, have introduced a measure of sanity to the sometimes vitriolic debates. Studies of the development and nature of expertise in an ever-increasing variety of areas —from reading and writing to mathematics and electronics, from physics and piano playing to baseball knowledge and chess—indicate that with proper instruction and practice, proficiency develops from novice to expert in an orderly way and is characterized by a sequence of more or less distinct stages.

Briefly, these studies demonstrate that proficiency and expertise are predicated upon five fundamental principles: (1) newly learned information is processed through a series of "memory registers," each of which is subject to different limitations and each capable of different kinds of storage and processing; (2) proficiency depends critically upon the acquisition of "automaticity," the capacity to respond automatically to certain components of complex tasks, such as number facts and words in context, thus reducing the processing load of working memory; (3) problem-solving ability and the ability to read with understanding are not mysterious competencies that some persons possess and other do not, but rather depend upon a specific, prerequisite knowledge base that can be acquired by most people; (4) expertise in a given domain (mathematics or chess, for example) depends crucially upon how relevant knowledge is organized and stored in long-term memory; and (5) proficient performance is either retarded or facilitated by how problems and text are represented internally.

It turns out that traditionalists and reformers were both right in their own way, but both were overzealous in their devotion to a particular mode of instruction and in their blanket dismissal of the competing point of view. The drill and practice advocates of early mathematics instruction, and to a lesser extent the phonics advocates of reading instruction, appreciated the importance of the second principle above, that certain, "low level" skills must become second nature in order for higher-level performance to emerge. But they often failed to follow through with tasks that engage and challenge. For their part, the new math and whole language advocates failed to fully appreciate the critical *enabling* role of automaticity, sometimes with disastrous results. Nor did they fully accept what we now know to be true—that automaticity develops only through continued practice distributed over appropriate intervals.

Throwing out the baby with the bath water may well characterize scientific revolutions, but in the world of education and schooling, where new claims must be tempered with the wisdom of practice, progress is rarely made in such spectacular fashion.

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