Toward a Pragmatics of Complex Transformation

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While browsing the abstracts of a recent issue of *Educational Evaluation and Policy Analysis*, a journal of the American Educational Researchers Association, I came across a report in which statistical methods were used to "control for" such "confounding variables" as "teachers, schools, and classrooms" (Pong & Pallas, 2001).

I had to read the abstract a few times, a little stunned by the fact that there still exist educational researchers who regard teachers, classrooms, and schools in such terms. It seemed like it had to be a parody, akin to a spoof of social science research that circulated several years back in which it was reported that a statistically significant correlation exists between utterances of the phrase "Please pass the salt" and the behavior of "salt passage."

Of course, not too many decades ago, studies rooted in statistical methods and assumptions were the rule of educational inquiry, not the exception. But that's changed. Dramatically. Surveys of library stacks and citation indices reveal that interpretive and critical discourses have won the day. And thankfully so. We know, deeply, that such nested and co-implicated influences as teachers in classrooms in schools cannot be bracketed or ignored in discussions of any aspect of formal education. That being said, the success in exorcising statistical analysis seems to have had an unfortunate side effect, namely concomitant rejections of scientific methods and mathematics-based tools of interpretation.

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Before I go much further, I should emphasize that I'm not advocating renewed embraces of the analytic method, rationalistic argument, or empiricist demonstrations around matters of learning, pedagogy, and curriculum. My point is, rather, that the contemporary habit of demonizing science as a mindless monolith is as problematic as the previous deification of analytic and statistical methods. That is, the tendency to couple "science" to "statistics" is an error, and one that might now be hindering curriculum studies when it could be supporting our efforts.

Just as there are many, many perspectives that might orient interpretive inquiry, there is a diversity of scientific attitudes. One particularly useful rubric for distinguishing among the varied interests and methods of science was proposed by physicist Warren Weaver in 1948. He noted that modern science has evolved around at least three different categories of phenomena, each of which lends itself to particular interpretive tools.

The first he called *simple systems*. These include collisions, orbits, ballistics, and other events that involve only two or three well-defined objects and their interactions—the sorts of events that are studied in high school physics and that occupied the attentions of Galileo, Descartes, and Newton. Such phenomena are suited to the ideals of prediction and control, through appropriate applications of the sorts of relatively simple and elegant mathematical laws that are presented in Newtonian mechanics.

However, Newton himself recognized that these systems of physical laws can give rise to intractable calculations when the number of interacting agents increases only slightly. Partially in response to this sort of realization, by the early 1800s scientists borrowed from a new class of analytic tools—probability and statistics—that mathematicians had invented to serve the needs of business (specifically, for the construction of mortuary tables for insurance companies). These tools were trained on phenomena that involved thousands, millions, and more particles and variables. Examples of *complicated* phenomena, Weaver's second category,[1] included flowing water, chemical reactions, air movements, and games of chance. The new methods also supported the emergence of a "stochasticized" mindset, as terms such as *probably* and *likely* took on new meanings and new prominence in both scientific and popular discourse (Davis & Hersh, 1987).

That being said, probability and chance were understood as a veneer that we humans, owing to our perceptual and conceptual limitations, were compelled to impose on a universe believed to be certain and pre-scripted. The underlying mentality was still deterministic, consistent with Pierre Laplace's pronouncement at the close of the 18th century:

> Given for one instant an intelligence which could comprehend all forces by which nature is animated and the respective situations of the beings which compose it—an intelligence sufficiently vast to submit these data to analyses—it would

> embrace in the same formula the movements of the greatest bodies and those of the lightest atom; for it, nothing would be uncertain and the future as the past, would be present to its eyes. (1795/1951, p. 3)

The move to probability and statistics, then, was in response to the realization that no flesh-based intelligence was sufficiently vast. It was commentary on the limits of humanity, not on the nature of the universe. There was no questioning of the laws of mechanics or their appropriate application, merely a resignation to the fact that increasingly complicated phenomena made for decreasingly reliable characterizations.

In fact, far from representing a break from prior mindsets, the development and embrace of probabilitistic and statistical models was an amplification of modernist sensibilities. This point is perhaps most apparent in the emergence of a discourse of normality—which was prompted and enabled in the coupling of Darwinism and statistics in the mid-1800s. In the process of dissolving the assumption that "creation" was static (actually, in dissolving the assumption of *creation*), Darwin proposed a mechanism that accounted for the emergence of diversity. He recast variety as something that was caused, not something that was pregiven. In the realm of the social sciences, it suddenly made sense to measure difference, to define "normal" in terms of arithmetic means, and to pathologize everything that "deviated" from arbitrary zones of "average".

With the 1900s came the gradual realization that these sorts of practices might be problematic. In the "hard sciences," this insight emerged in the articulation of a previously unrecognized category of phenomena that yielded neither to Newtonian mechanics nor to statistical analysis. These instances of *complexity*, in Weaver's terms, include brain function, stock market activity, cultural evolution—in effect, phenomena that are dynamically adaptive and that we tend to describe or regard as living systems. (I might also mention that teachers, classrooms, and schools—and other phenomena that some researchers continue to ignore and factor out as confounding variables—fall into this category.) Such forms sustain their existence in the ongoing generation of diverse possibilities, which means that methods that seek to define universal rules or normal ranges of acceptability are utterly inappropriate for their study.

Unfortunately, social science research had already dug itself into a statistics-lined hole by the time proposals such as Weaver's had begun to emerge within the scientific establishment. And those who recognized social science research to be in a rut tended to blame the imagined culprit of a unified and monolithic science rather than overzealous and uninformed researchers for the problem. The critical point here is that the spread of statistical methods among educational researchers, while enabled by science and mathematics, was certainly not a proper reflection of those cultural projects.

Rather, statistics-based educational research occurred in *ignorance* of science and mathematics—an ignorance that was and is supported by schooled versions of these discourse systems. The following commentaries, all from prominent mathematicians, underscore this point:

> [Some] psychologists and sociologists have come around with their questionnaires and chi-square statistics, purporting to study the human mind quantitatively, but most such investigations are so remote from the target that the critic need hardly say, "Pooh!" They fall over of their own absurdity and pomposity. (Davis & Hersh, 1987, p. 13)

> The introduction of mathematical methods in biology, economics, psychology, and other branches of the . . . behavioral sciences has always been accompanied by controversy. . . . [It] is important to state publicly that among professional mathematicians the skepticism about behavioral-science mathematics . . . is much stronger than it is among non-mathematical behavioral scientists. (ibid., p. 61)

> Too much research in the social sciences . . . is a mindless collection of . . . meaningless data. If property X (say, humor) is defined in this way (number of laughs elicited by a collection of jokes), and property Y (say, self-esteem) is defined in that way (number of yes responses to a series of positive traits), then the correlation coefficient between humor and self-esteem is .217. Worthless stuff. (Paulos, 1988, p. 161)

Stewart & Golubitsky (1992) (also mathematicians) offer one explanation for the sorts of concerns announced above. In brief, they suggest that two tools of interpretation have been inappropriately collapsed:

> Linear models are based upon straight lines, flat planes, and constant growth rates. Nonlinear models are based upon curves and variable growth rates. If, like the classical mathematicians, you want to write down *formulas* that solve your equations, then it's best to stick to linear models. But, with computers and new mathematical tools such as topology, formulas have taken a back seat. Nonlinear models are more interesting, and generally fit nature better. All too often a nonlinear system has been forced into a linear mould (a round peg into a square hole!) in order to obtain an answer. The philosophy behind this approach seems to be that a wrong answer, or the right answer to the wrong question, is better than no answer at all. (p. 171)

This important distinction between linear and nonlinear models roughly parallels Weaver's distinction between complicated systems (which tend to be mechanical, and hence predictable in general terms) and organized complexity (which tends more toward the organic). Indeed, another name for complexity science is *nonlinear dynamics*.

What's important here is that science and mathematics have developed tools that are valuable for understanding complex phenomena like learning and learners—and part of this development has been a shift in what is meant by "understanding a phenomenon." For a complex event, such understanding is not about control and prediction, but about the capacities to follow the ongoing evolutions of a form or agent and to make sense of its emergent structures. Within these sorts of interpretive projects, mathematics and science have taken on a role that is different from what the original rationalists and empiricists imagined. The aim now is more about the development of useful descriptions and illustrations than about the production of explanatory principles.

I've found it necessary to resist the temptation to provide hasty summaries of such the descriptions and illustrations. Unfortunately, just like Darwinian processes and statistical methods when they were first introduced, complexity science lends itself to misinterpretation and misappropriation in the hands of persons working from a prior mindset. To appreciate complexity, one must first learn to live with/in a few rather radical breaks with accepted wisdom. One is the idea of "order for free," whereby complex and transcendent unities can arise in the co-specifying activities of seemingly autonomous entities. Ants spontaneously self-organize into anthills, birds into flocks, traders into markets, species into ecosystems, and so on. (This is where complexivists tend to lose modernists, with their insistence on autonomous, self-contained subjects.) And it all happens without leaders or intentions. (This is where complexivists tend to part company with those postmodernists who are committed to the metaphor of "power" as a property of and motivator in the evolution of systems.)

Closely related to this dynamic of self-organization is the suggestion that the human being might be better considered in terms of an agent that is nested within several different sorts of grander social and/or cultural agents. I am, simultaneously, a learning unity, a collective of learning unities, and a subunit of many different learning unities—a suggestion that renders problematic both sides of such contemporary educational debates as teacher- versus student-centered classrooms, nature versus nurture, individual versus social interests, and so on. Complexity science is a science of entanglement, not of distinction-making. It is about participation, not specification.

An important caveat of this sort of discussion is that a complex phenomenon is *irreducible*. It transcends its parts, and so cannot be studied strictly in terms of a compilation of those parts. It must be studied, that is, at the level of its emergence. Classrooms aren't just collections of students, schools aren't just collections of classrooms. As such, complexity science provides a means to read across cognitive, social, situated, critical, cultural, and ecological discourses—without collapsing them or their particular foci into unitary or coherent phenomena. According to complexity science, such discourses can be simultaneously appropriate to their object of study and incompatible with one another. We don't need to agree to be correct.

Further to this point, one of the reasons that complexity science is useful for reading across diverse discourses is that it explicitly embraces many of the insights and sensibilities that arose over the past century in such fields as phenomenology, psychoanalysis, and pragmatism. This is a topic that I develop in detail elsewhere (Davis, forthcoming) in an extended discussion of the evolutions of Western conceptions of teaching away from discourses that are rooted in metaphysics and toward interpretations that are grounded in the physical. Consider, for example, the opening three lines of Lakoff and Johnson's (1999) *Philosophy in the Flesh*, a text out of cognitive science that is explicitly informed by complexity science:

> The mind is inherently embodied.
> Thought is mostly unconscious.
> Abstract concepts are largely metaphorical. (p. 3)

The first line hints at Merleau-Ponty's phenomenology, the second reminds of Freud's psychoanalysis, the third recalls Dewey's pragmatism. What's more is that complexity science is not just interested in describing complex phenomena. It joins with psychoanalysis as one of the few Western discourses with an explicit interest in articulating what might be described as *a pragmatics of transformation*. Complexivists, that is, are as much interested in occasioning complexity and triggering transformations as they are in studying existing instances of complexity. Two of the conditions that are necessary have been deliberately incorporated into the structure of this inaugural issue of the *Journal of the Canadian Association for Curriculum Studies*—namely, diversity among parts and the juxtaposition of that diversity in ways that might trigger new individual and/or collective possibilities.

These same sorts of conditions can be deliberately woven into classrooms, but almost never are. Education hasn't paid much attention to this particular pragmatics of transformation—unlike business, economics, politics, ethics, law, and several branches of medicine, including immunology and neurology. I suspect that part of the reason for the slow uptake among educationalists has to do with the overwhelming commitment to linearity and linear causality, inscribed in institutional structures, classroom resources, developmentalist theories, curriculum intentions, and pedagogical methods. It may be that, until we are collectively willing to face the prospect that the formal educational project is deeply problematic, complexity science must be relegated to that class of educationally unbearable discourses that includes (among its many honorable members) psychoanalysis, pragmatism, and poststructuralism.

Note

[1] Weaver actually used the term "disorganized complexity" to refer to his second category. "Complicated" is the preferred word at the moment for this class of phenomena. See Waldrop (1992).

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