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Social Science and Educational Innovation

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Can developments in the social sciences justifiably lead to significant innovations in education, innovations that are widely accepted? In an article published in 1983 I defended the more general claim that "any technology generated by ideas drawn from the social sciences is likely *already* to exist."[1] The reason *natural* science could lead to technological breakthroughs, I argued, was because it discovered causal mechanisms previously unknown, mechanisms that could be exploited to produce desired effects. The social sciences, on the other hand, did not discover such novel mechanisms, but rather made use of or depended on already familiar mechanisms to explain normal and even anomalous human phenomena. So I argued.

I now think that this thesis is only partly true. I believe that the social sciences *are* capable of blazing novel trails for practical enterprises though the means by which they do so is distinctive. At the same time, the “inventions” deriving from the social sciences may fail to revolutionize practice, not because these inventions are found to be ineffective but because they are *rejected* by the intended users. I shall use a couple of educational innovations to illustrate these possibilities. First, though, let me review the way in which *natural* science typically breaks new trails for technology by briefly describing a recent example.

Invention Based on Natural Science

A recent article by Gina Kolata in the *New York Times* describes a new approach to combating AIDS. The new approach is based on the idea that the "virus subverts the cell's genetic machinery almost as if it were a mutant human gene."[2] One key agent in the replication of the virus within the cell is a protein, "rev," that transports copies of "most of the virus's genetic messages from the nucleus of a cell into the surrounding cytoplasm.[3] An idea being tested by Dr. Gary J. Nabel at the University of Michigan is injection of a vector into patients' white blood cells that subtly alters the rev protein, preventing the transportation of the genetic messages out of the nucleus of infected cells, thus cutting off production of new HIV. Of the new genetic approach, Dr. Nabel is quoted as saying, "If you compare it to traditional drug development, in many ways it's an intellectual watershed. Rather than pursuing drugs by trial and error, this allows us to use our knowledge base to design strategies."[4]

This illustration of what might be called the reductionist strategy is typical: An understanding of micro structures and processes invisible to the naked eye (some even to microscopes) is used in designing novel means of intervention to create desirable changes at the macro level. As the record of earlier generations of physicians and alchemists makes clear, interventions that do not understand or fail to take account of the micro level of organization are usually impotent. A patient suffering from fatigue or weakness due to AIDS may be helped temporarily by a transfusion of blood from a healthy donor, for example, but such a transfusion would not halt the replication of the virus bent on destroying the patient's immune system. Of course, it is well to remember that although a single scientific advance may be responsible for a revolutionary invention, new technologies depend for their success on myriad developments in many fields of investigation.

Invention Based on Social Science

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Innovations which augment our ability to promote and enhance some aspect of human well-being through the design of new social "devices," that is, new techniques, practices and institutions, I shall call social inventions. Jury trials, scholarships for indigent students, graded classrooms, one-way streets, junk bonds, auctions, alphabetic writing, parliamentary procedure, management by objectives, mortgages, opinion polls -- these are all examples of social inventions. While dependent on material artifacts, they are not themselves artifacts. What makes such inventions possible? Most result from the creativity of resourceful, visionary practitioners. My rejection of the social sciences as sources of such inventions was based on the idea that the reductionist strategy illustrated above cannot yield commensurate payoffs because the micro level, far from being imperceptible, is where we *live* . Our socialization gives us a pretty good understanding of the mechanisms that operate at the level of the individual human actor.

This argument notwithstanding, potentially significant social inventions may nonetheless derive from the social sciences. I shall argue that the sources of such innovations lie not in the discovery of previously unknown causal mechanisms, however, but rather in the novel way in which social scientists may construe problematic situations. (Of course the new approach to attacking the HIV virus depends on re-construing a *research* problem; but the physician's problem is not thereby changed, namely, that of finding a way to eliminate or disable the virus.) Let me illustrate with two educational innovations: the first, a scheme for financing professional or vocational education proposed by Milton Friedman in 1963; the second, Logo, the computer language designed as a learning tool for children, developed by Seymour Papert in the late 1960s.[5]

Consider the first: Why is payment for occupational training a problem for those seeking it? The answer is evident: many future professionals (or their families) may lack the financial resources to pay for the necessary training. Friedman argues, "If capital were *as readily available for investment in human beings as for investment in physical assets*…the rate of return on capital would tend to be roughly equal in the two fields."[6] But, Friedman observes, the return on investment in human beings is considerably higher, which suggests an underinvestment in human capital, a reflection of "imperfection in the capital market," notably high risk.[7] Friedman notes that the device adopted to meet this problem "for *other risky investments* is equity investment plus limited liability on the part of the shareholders."[8]

> The counterpart for education would be to 'buy' a share in an individual's earning prospects; to advance him the funds needed to finance his training on condition that he agree to pay the lender a specified fraction of his future earnings. In this way, a lender would get back more than his initial investment from relatively successful individuals, which would compensate for the failure to recoup his original investment from the unsuccessful.[9]

Friedman asks why such a scheme has not been tried. His answer identifies a number of factors,

> It seems highly likely, however, that a major role has also been played by the cumulative effect of the novelty of the idea, *the reluctance to think of investment in human beings as strictly comparable to investment in physical assets*, the resultant likelihood of irrational public condemnation of such contracts.[10]

The point I want to emphasize here is that Professor Friedman's *lack* of reluctance to think of investment in human beings as comparable to investment in physical assets, his ability to construe the problem of how to pay for professional education as subsuming the more general problem of underinvestment due to imperfect capital markets in general -- is precisely the result of his viewing the phenomenon from the point of view of classical economics. Although Friedman's analysis emerges from the framework of the discipline, I do not mean to suggest that most or even a substantial number of economists would endorse Friedman's "device" for overcoming it. What I would claim is that it is highly unlikely that, given the "common sense" aversion to viewing human beings as capital investments, a non-economist would have viewed the problem through this particular lens; it is the unfamiliar construal of the problem from the point of view of common sense that leads quite naturally to the innovative proposal.[11]

My second illustration is Papert's invention of Logo. Obviously programming languages depend on the existence of computers, but this particular language depended for its creation, not on developments in computer science, but on an insight derived from Piagetian developmental psychology. According to Papert's account, he had been "fixated on children in School and so was looking for ways to improve the guidance process in traditional schoolwork."[12] On a visit to Cyprus, Papert was thinking about

> how concepts related to computers were changing my thinking in many different areas. Then in a flash came the "obvious" idea: What computers had offered me was exactly what they should offer children! They should serve children as instruments to work In a search for good examples of what children might actually do with computers, my mind raced through my own activities… Then I remembered a conversation with Piaget a few years before in which we had engaged in playful speculation about what would happen if children could play at building little artificial minds… Piaget liked the image of taking one of his favorite aphorisms -- "to understand is to invent" -- into a new domain. In the hothouse atmosphere of the discussion in Piaget's incredibly chaotic study, we were carried away by images of children understanding thinking through playing with materials needed to invent a thinking machine, an intelligence… But now suddenly on a mountain in Cyprus, the idea changed for me from a speculation to a real project.[13]

Papert had the idea that children could learn about thinking by learning how to program computers to do something intelligent like playing a game, but for that to be feasible, "the only sensible approach was to take a first shot at making a programming language that had a better chance of matching the needs and capabilities of younger people than the existing ones."[14] What Piaget's psychology contributed to Papert's invention was a way of looking at how children learn that is quite different from the one which inspires conventional schooling. Piaget's psychology helped Papert construe the educational problem differently. Whereas Papert had originally been thinking of the computer as a better *conduit* for knowledge, he now saw the challenge as designing a learning environment in which subject-matter mastery would be a *by-product* of children's engagement with projects of their own design.

What standard economic analysis, on the one hand, and Piaget's psychology, on the other, made possible was an unorthodox construal of a practical problem, one that facilitated the invention of a novel "device."

Resistance to Educational Innovation

It is too early to say whether the genetic approach to treating AIDS will result in a major breakthrough in the search for a cure though it well may. It is probably safe to say that neither Friedman's investment scheme nor Logo are the "breakthroughs" in the way schooling is conducted or financed that their respective inventors hope for. Why not? Someone might say that the devices do not really work, but that obscures more than it illuminates. The truth of the matter is that one has never been adopted and the other one has not been introduced in the way envisaged by its inventor. While it is true that banks and professional schools make loans to students entering vocational and professional schools these are relatively standard loans, not shares in the *lifetime* earnings of future professionals. While it is also true that computers exist on a large scale in elementary and middle schools, these are rarely used in the way Papert intended.

> Little by little the subversive features of the computer were eroded away: instead of changing the emphasis from impersonal curriculum to excited live exploration by students, the computer was now used to reinforce School's ways. What had started as a subversive instrument of change was neutralized by the system and converted into an instrument of consolidation.[15]

Each of these inventions has encountered *resistance* precisely because the source of the innovation, its construal of the problem, is *contested*. (Education vouchers, another of Friedman's inventions, has also encountered resistance and has yet to win acceptance by a majority of voters in any state.) Both Friedman's and Papert's inventions must be seen, not as neutral means to agreed-upon ends, but *as devices generated by and tied to distinctive normative visions or ideologies*. Friedman's device is tied to a classical liberal's view of the scope and limits of government activity while Papert's is

connected to a progressive educational philosophy. Let me elaborate, starting with the investment scheme.

Friedman notes that in most states, occupational training is financed or subsidized by the government rather than paid for exclusively by the recipients themselves. What's wrong with that? According to Friedman, the sole beneficiary of occupational training is the student whose future income will be higher than it otherwise would be. If occupational training is financed from general revenues, the future beneficiaries incur none of the costs. Hence, according to Friedman, many more candidates will wish to attend professional and vocational schools than would otherwise be the case. Since available funds would not cover every student desiring occupational training, some kind of rationing will be inevitable.

> Those fortunate enough to get their training subsidized would receive all the returns from the investment whereas the costs would be borne by the taxpayers in general -- an *entirely arbitrary* and almost surely perverse redistribution of income.[16]

One might, unlike Friedman, think that there are *social* gains to occupational training which exceed the personal gains to that investment.[17] On such a view, the well being of society is enhanced when highly trained individuals provide the services we all depend on. Government might then be justified in underwriting occupational training. On this view, the financial returns to individual practitioners provide an accurate indicator of their usefulness to the *individuals* whom they serve but not necessarily of their contribution to *social welfare*. It could be asserted, for example, that family physicians are more valuable than cardiologists, that child-care workers are as important as copywriters. Following this line of reasoning, it would make sense for the public to provide incentives for qualified candidates to enter *particular* occupations by subsidizing their training, by taxing other occupations, or by putting quotas on the numbers of people who could enter certain occupations. Proponents of this view could argue that though such measures admittedly redistribute income, such a redistribution would by no means be arbitrary and, in any case, preferable to a situation in which the talented poor might owe a share of their *lifetime* income to the investors who financed their training, placing such individuals in a situation Friedman *himself* labels "partial *slavery*."[18]

Friedman believes that government activity should be severely curtailed. In education, the proper role of government is confined to requiring some minimum of schooling for all children and subsidizing those parents unable to afford it. The alternative sees a much broader role for government in attending to the general welfare. In education, that role might include subsidy and operation of schools at all levels from child-care centers to professional schools.

Turning now to our second case, Papert, as we have already noted, feels that the spirit which animated his invention has been betrayed, that computers have been installed in schools to serve an alternative vision he calls "School."[19] Papert himself identifies the broad features of the alternative view in an avowedly caricatured fashion as follows:

> Knowledge is made of atomic pieces called facts and concepts and skills. A good citizen needs to possess 40,000 of these atoms. Children can acquire[20] atoms per day. A little calculation shows that… the operation will have to be well organized.… It follows that the technicians in charge (hereafter called teachers) have to follow a careful plan (hereafter called the curriculum) that is coordinated over the entire 12 years.… The problem of quality control is facilitated by the discovery that there are hierarchical relations among the atoms: Facts fall under concepts, concepts can be classified as subjects, and subjects split up as grade levels. A hierarchy of people can be constructed to match the hierarchy of knowledge.20

Papert himself summarizes the competing philosophies of education as follows:

> Traditional education codifies what it thinks citizens need to know and sets out to feed children this "fish." Constructionism is built on the assumption that children will do best by finding ("fishing") for themselves

the specific knowledge they need; organized or informal education can help most by making sure they are supported morally, psychologically, materially, and intellectually in their efforts.[21]

VISION AND KNOWLEDGE

Neither of the devices I have been discussing are "neutral" tools; each is linked to a normative view, yet each is the work of a man deeply immersed in a social *science*. When he wrote *Capitalism and Freedom*, Friedman was a widely respected economic scientist, not just a gifted pamphleteer for classical liberalism. Papert's invention came after spending five years in Geneva immersed with Piaget in the study of human development. The question may therefore be raised of how, if at all, the normative vision of each inventor is connected to the way they understand the world through their discipline. Are these entirely separate things?

I think Friedman's normative vision is closely connected to a free market economist's insight, namely that any government program, such as subsidies for occupational training, can be viewed as a transfer of resources from all taxpayers to particular beneficiaries, a transfer in which, as Friedman notes, quoting A.V. Dicey, "the beneficial effect is direct, immediate, and, so to speak, visible, whilst its evil effects are gradual and indirect, and lie out of sight."[22] Of course, one who is alert to the less visible liabilities of *government* intervention is less likely to entertain the opposing and equally valid view that "private" transactions invariably have effects that go beyond the contracting parties, effects not registered by the market. The transactions between the television networks and the advertisers could be used to illustrate the point.

Papert's normative vision is connected, I believe, to an important insight, as well, one deriving from Piaget's understanding of child development, namely that children learn to perform some of the most intricate and demanding tasks in the human repertoire without benefit of formal tutelage. His educational vision derives from extrapolating this insight into areas of the school curriculum. Noting the ease with which, under proper conditions, children learn a second language, Papert wonders, for example, whether a mathematics environment could not be designed that would facilitate equivalent mastery in mathematics without recourse to direct instruction.[23] Here, the insight is partial as well, ignoring the perspective gained from considering the paths to mastery exemplified by the accomplished gymnast or the violinist. This latter is the perspective taken by a math teacher recently interviewed by a local columnist. She is quoted as saying "Even the best have to practice -- whether it's football or the piano or math equations. It's repetition. And if kids aren't forced to study, they won't get smart. It's that simple."[24]

CONCLUSION

I have offered two illustrations of the way that social sciences can contribute to the development of novel technologies. The novelty depends, not on the discovery of new causal pathways, but on the ability of the inventor to construe a familiar problem in an unfamiliar way. This novel construal derives from the distinctive perspective provided by looking at the problem through the lens offered by the discipline. Just because the vision is partial, the "device" is less likely to suggest itself to common sense. By the same token its partiality virtually guarantees that it will be resisted by those committed to an alternative view of the nature of the problem the "device" is expected to solve.

In claiming that the new approach to combating AIDS resulted from the discovery of a new causal pathway, I may have left the impression that the new cure (if effective) was *not* tied to a *normative* vision of illness and cure. The impression is false. This medical research program does flow from a normative view, but it is a view that so many of us share that we may not be aware of it as but one of a number of possible alternatives. According to this dominant view, contracting HIV is the result of bad luck or, perhaps, imprudence but it is not, for example, the wages of sin, not part of God's plan for the victims. Hence when a person's body is attacked by a pathogen like the HIV virus, we believe every effort must be made to destroy the invader. Standing by or merely alleviating suffering is not enough if more can be done.

Even though we believe that lives must be saved at virtually any cost, there are limits to what many would be prepared to do. Suppose that the "genetic approach" described in the *Times* article yields a promising cure, but one that requires the injection of fetal tissue. Now it is possible to imagine some people *resisting* the innovation, arguing that the good the new treatment offers, is purchased at too high a price, that it is *wrong* to save one life by taking another.

Almost any invention, whether embodied in an artifact or not, will embody a normative dimension if only by facilitating certain actions and discouraging others, reinforcing a particular perspective at the expense of others. Even a simple innovation such as a one-way street designed to facilitate the flow of traffic and eliminate bottlenecks on a busy thoroughfare is likely to stimulate vehicular traffic increasing the likelihood that the neighborhood is seen as a place to pass *through*. That being the case, perhaps what needs explaining is not the kind of resistance to innovations described above but the *lack* of resistance to so many innovations -- be they in transportation, medicine, communications or construction. Part of the answer lies in the fact that scientific discoveries in the natural sciences do lead to the deployment of novel, sometimes awesome, ways to make nature obey our wishes. Part of the answer lies elsewhere, in the observation that Dicey made in the text that Friedman cited, namely the fact that the benefits of many innovations are immediate and obvious while their drawbacks are hidden and slow in presenting themselves. Chemical pesticides provide an obvious example. Looked at one way, education makes scant progress as every putative innovation is contested. Looked at another way, we are more thoughtful about education because we are not locked into a single normative vision. It is precisely in the areas where progress appears so obvious, in transportation, building, medicine that our sensitivity to the possibility of alternative perspectives appears most needed.

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1. Francis Schrag, "Social Science and Social Practice," *Inquiry* 26 (1983): 108, (emphasis added).

2. Gina Kolata, "Genetic Attacks Readied on Aids," *The New York Times*, 31 May 1994, B5.

3. Ibid.

4. Ibid., B6

5. Milton Friedman, *Capitalism & Freedom* (Chicago: University of Chicago Press, 1962); Seymour Papert, *The Children's Machine: Rethinking School in the Age of the Computer* (New York: Basic Books, 1993).

6. Friedman, *Capitalism*, 101, (emphasis added).

7. Ibid., 102.

8. Ibid., 103.

9. Ibid.

10. Ibid., 104, (emphasis added).

11. What is "common sense" for *us* might and probably was not for other epochs. Under slavery, the notion of investing in human beings was only too natural. In the heyday of classical liberalism in the Nineteenth Century, Friedman's scheme might not have been considered novel at all.

12. Papert, *Children's Machine*, 168

13. Ibid., 168-69.

14. Ibid., 171.

15. Ibid., 39.

16. Friedman, *Capitalism*, 105.

17. See, for example, Charles W. Anderson, *Pragmatic Liberalism*. (Chicago: University of Chicago Press, 1990).

18. Friedman, *Capitalism*, 103, (emphasis added).

19. The drill and practice programs which dominate school computing do not use Logo but other computing languages such as Basic, (personal communication from Michael Streibel).

20. Papert, *Children's Machine*, 62.

21. Ibid., 139.

22. A.V. Dicey, *Law and Public Opinion in England*, 2d ed., (London: Macmillan, 1914), 257-58, cited in Friedman, *Capitalism*, 201.

23. Friedman, *Capitalism*, 64.

24. Rob Zaleski, "U.S Kids Triumph in Math," *Capital Times*, 6-7 August 1994, 4D.
