Why School Reform Is Impossible

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The following pieces appeared in *The Journal of the Learning Sciences*, 6(4), pp. 417-427.

The first is a review of David Tyack and Larry Cuban's *Tinkering Towards Utopia: A Century of Public School Reform.* Cambridge, MA: Harvard University Press, 1995, 184 pp.

The second is commentary on O'Shea's and Koschmann's reviews of Seymour Papert's *The Children's Machine.*

The common theme of *Tinkering Towards Utopia* and the two reviews of *The Children's Machine* is the failure of educational reform to change School.(1) O'Shea and Koschmann each tell aspects of a story in which the failed reform is the "LOGO movement." Tyack and Cuban present a story of larger scope whose plot starts with the birth of the generic twentieth century American education reform movement, develops through its interaction with School and ends leaving School essentially unchanged. The following pages are the outcome of my attempt to understand all three texts by situating them in an even larger story about change in education.

Reform Versus Evolution

My first reaction to *Tinkering Towards Utopia* was adversarial. I am convinced that education will undergo the kind of megachange that came in the wake of technological and scientific developments in areas such as medicine. Yet as Koschmann pointed out in the introduction to this section, although Tyack and Cuban present their work as analysis of the past, "the implication is plain that the prospects for any technology, ... leading to radical change in our educational institutions appear quite bleak" (Koschmann & Kolodner, this issue, p. 399). One of us, it seemed at first sight, has to be wrong.

Only at first sight. Working on this review brought me the intellectual bonus of a better understanding of my own position by making explicit a simple distinction that has long lurked unformulated in the shadows of my intuitions: "Reform" and "change" are not synonymous. Tyack and Cuban clinched my belief that the prospects really are indeed bleak for deep change coming from deliberate attempts to impose a specific new form on education. However, some changes, arguably the most important ones in social cultural spheres, come about by evolution rather than by deliberate design -- by what I am inspired by Dan Dennett (1994) to call "Darwinian design." (2) For example, the concept of learning disability entered School in a manner more akin to the way that memes invade cultures than to the conduct of an education reform movement; institutionalization from above followed the cultural movement.

Examples closer to my focus here are to be found in the unintended effects on the classroom of the presence of computers in homes. The title of an article by Cuban (1992), "Computers Meet Classroom: Classroom Wins," refers to School's defense mechanisms against reform being brought into the classroom by computers. School exerts less influence on what children do with home computers, and as the number of these reaches significant levels, we are beginning to observe changes in the relationship between teachers and students brought about not by a reform, but by the fact that the students have acquired a new kind of sophistication -- not only about computers but also about ways to learn and methods of research (Papert, 1996a).

With the evolution-reform distinction in mind, I found myself reading *Tinkering Towards Utopia* more sympathetically. I could now appreciate the elucidation of mechanisms by which the system systematically frustrates reform without feeling obliged to defend my own intellectual commitments. In fact, I could learn from it -- the shift from a stance of reform to a stance of evolution does not exclude active intervention, but the role of the change agent becomes less like the architect or builder and more like the plant- or animal breeder whose interventions take the form of influencing processes that have their own dynamic. *Tinkering Towards Utopia* is a gold mine of insights into the dynamic of School's defense mechanisms.

Nevertheless, a sense of residual discomfort lasted until I managed to formulate yet another respect in which *Tinkering Towards Utopia* says less than I first thought: The mechanisms described in it are concomitants rather than causes of the stability of School. Making this distinction will lead me to suggest that Tyack and Cuban are blinded to a deeper layer of explanation by a theoretical stance that looks deeply into the sociological processes at play in education while treating as a black box the actual content of what is being taught and (supposedly) learned.

Cognitive Science Versus Sociology of Institutions

The contrast between the sociological stance of *Tinkering Towards Utopia* and the cognitive stance of the two reviews of *The Children's Machine* is characteristic of large sub communities in education research and innovation: At a typical conference on educational technology virtually all the talk is in the style represented by O'Shea and Koschmann; at a conference on restructuring schools virtually all is in the style represented by Tyack and Cuban. In the hope of bridging this separation by showing complementary strengths and weaknesses of the two sides, I take a quick look at two ways of thinking about why LOGO, and in fact, the computer presence in general, has not had a bigger effect on School. The need for bridging may be seen by reflecting on the sense in which Tyack and Cuban are overly sociological and O'Shea overly cognitive.

Discourse in the educational technology culture tends to have an aura of "scientific method": LOGO is based on a theory of learning; experiments were mounted to test predictions made from this theory; the predictions were or were not verified. I shall comment later on the interpretation of the experiments, but what is relevant for the moment is the contrast with another way of thinking that gives little importance to the truth or falsity of cognitive theories in influencing, one way or another, the fate of education reforms. In The Children's Machine, I tell a story in terms of institutional and cultural dynamics rather than of cognitive science along the lines of the following brief outline: The first microcomputers in schools were in the classrooms of visionary teachers who used them (often with LOGO) in very personal ways to cut across deeply rooted features of School (what Tyack and Cuban neatly call "the grammar of school") such as a bureaucratically imposed linear curriculum, separation of subjects, and depersonalization of work. School responded to this foreign body by an "immune reaction" that blocked these subversive features: The control of computers was shifted from the classrooms of subversive teachers into "computer labs" isolated from the mainstream of learning, a computer curriculum was developed... in short, before the computer could change School, School changed the computer.

Unless I am missing Tyack and Cuban's point, this account is in the spirit of *Tinkering Towards Utopia* and in fact, exemplifies one of the major principles in its presentation of the generic life-cycle of reforms: The reform sets out to change School but in the end School changes the reform. One may at first blush see a tautology in using this proposition to explain failures of reform. But to say that School changes the reform is very different from simply saying that School resists or rejects the reform. It resists the reform in a particular way -- by appropriating or assimilating it to its own structures. By doing so, it defuses the reformers and sometimes manages to take in something of what they are proposing.

A Piagetian Model of Educational Development

The word "assimilation" in the previous paragraph is a first step in an assimilation of the Tyack-Cuban analysis to a Piagetian view (generalized from a theory of the child to apply to institutions such as School) in which development advances through a series of temporarily stable states of equilibrium. (3) Transferring Piaget's language to this context, I see Tyack and Cuban as discussing what happens within a stage of development while my perception of imminent change in education is more like the transition to a new stage.

The difference between intra-stage and inter-stage phenomena is categorical: The former has to do with how a system in equilibrium functions whereas the latter has to do with breakdown of existing states of equilibrium and the emergence of new ones. I see School as a system in which major components have developed harmonious and mutually supportive -- mutually matched forms. There is a match of curriculum content, of epistemological framework, of organizational structure, and -- here comes the trickiest point for Tyack and Cuban -- of knowledge technology. A typical failed education reform is like tweaking one component of a well-equilibrated dynamic system: When you let go it is pulled back by all the other components. *Tinkering Towards Utopia* describes the processes by which the tweaked component springs back into its equilibrium position but says nothing about the nature or the source of the equilibrium and most seriously, is blind to the forces most likely to break it.

In *Mindstorms* (Papert, 1980), I asked (choosing one out of a vast number of possible examples) why the quadratic equation of the parabola is included in the mathematical knowledge every educated citizen is expected to know. Saying that it is "good math" is not enough reason: The curriculum includes only a minute sliver of the total body of good mathematics. The real reason is that it matches the technology of pencil and paper: It is easy for a student to draw the curve on squared paper and for a teacher to verify that the assignment has been done correctly.

I have noted elsewhere (Papert, 1996b), that School's math can be characterized by the fact that its typical act is making marks on paper. *Explorations in the Space of Mathematics Education* develops this idea by imagining an alternative mathematical education in which the typical activity begins with and consists of creating, modifying, or controlling dynamic computational objects. In this context the parabola may be first encountered by a child creating a videogame as the trajectory of an animal's leap or a missile's flight; here, the natural first formalism for the parabola is an expression in a child-appropriate computational language of something like "the path followed when horizontal speed and vertical acceleration are both constant."

Many readers will say that is too abstract for children. This is because they have in mind children who grew up using the static medium of pencil and paper as the primary medium for representing mathematical ideas. Attempts to inject this treatment of the parabola as an isolated innovation into an otherwise unchanged School will confirm their negative view. For children who have acquired true computational fluency by growing up with the dynamic medium as a primary representation for mathematical thinking, I argue that it would plausibly be more concrete, more intuitive, and far more motivating than quadratic equations. My experiments support this expectation by showing that the dynamic definition is indeed accessible even to elementary school children who are given the opportunity to acquire a degree of computational fluency that is still very limited though considerably more than a few students develop in what are misleadingly called computer labs in contemporary schools.

Assimilation Blindness

I am grateful to Tyack and Cuban for their concept of a "grammar of school." The structure of School is so deeply rooted that one reacts to deviations from it as one would to a grammatically deviant utterance: Both feel wrong on a level deeper than one's ability to formulate reasons. This phenomenon is related to "assimilation blindness" insofar as it refers to a mechanism of mental closure to foreign ideas. I would make the relation even closer by noting that when one is not paying careful attention, one often actually hear the deviant utterance as the "nearest" grammatical utterance a transformation that might bring drastic change in meaning.

I see an example of this in Tyack and Cuban's assimilation of the computer to a concept of "electronic pedagogy" -- a "teaching machine" -- that puts it in the same category as radio, movies, tape recorders, and the like. The superficial physical resemblance cannot be a sufficient reason for lumping these diverse things together -- nobody puts textbooks and comic strips in the same category just because they are made of paper. The real reason is that the constructionist use of the computer has no place in the grammar of school, which casts everything in the role of teaching device and thus, creates an assimilation blindness to the use of computers to support noninstructionist forms of learning. The point can be seen most simply by borrowing from experimental psycho-linguists a standard test for assimilation. If you ask, "Which is not like the other two?" in the list "educational movie, textbook, computer," it is pretty obvious from my perspective that the answer must be "computer." The choice of "textbook" that is implicit in *Tinkering Towards Utopia*'s use of language appears to me to be a clear example of assimilating the new technology to the old grammar of School -- as is the fact that although Tyack and Cuban do not consider constructionist uses of the computer to be worth mentioning, they give prominent mention to Edison's prediction that the motion picture would displace the textbook. (4)

I see two prima facie objections to this analysis. The simplest is to shift the responsibility for the assimilation from the minds of the theoretical observer to the practices of schools: Instructionist uses in conformity with the grammar of school constitute the reality that the theorist is trying to interpret. However, in the context of explaining why schools don't change this begs the question: For surely School's assimilation (even if it were universal, which it is not) is part of what has to be explained and in my view the essential part. The more substantial objection appeals to a widely held belief that research has shown that the noninstructionist uses of the computer are mere chimera based on romantic unfulfilled claims. It is therefore appropriate to take a look at the kinds of discourse from which these beliefs have developed. I do this by focusing on one case in which I have been centrally involved.

But Didn't Roy Pea Refute This "LOGO Vision"?

In his review of The Children's Machine, O'Shea at least partly endorses the belief that Roy Pea (and others) demonstrated that "LOGO did not live up to Papert's predictions" (cf. Pea & Kurland, 1984; Papert, 1987; Noss & Hoyles, 1996; Koschmann, this issue). In the spirit of elucidating the logic of the belief, I use a review of some history to make two related points. First, Pea's experiment (Pea & Kurland, 1984) and some of O' Shea's comments reflect an assimilation of my thesis to the grammar of school by reading it as a statement about improving rather than radically changing School. Second, although I and many others (including Koschmann, this issue) have pointed to specific flaws of experimental method in the procedures adopted by Pea and Kurland, a more fundamental flaw lies in the fact that no experiment on the paradigm of school psychology could refute my thesis. Indeed, one may be more justified in leveling at me the Popperian criticism that my thesis is not amenable to refutation at all. Perhaps so, but that is a horse of a different color.

The intention of *Mindstorms* was really to deconstruct the necessity of School by showing that something very different -- far more different than the reforms discussed by Tyack and Cuban -- could at least be imagined. In the first chapter, I explicitly cast my goal in terms that fit the Tyack and Cuban perspective: "Conservatism in the world of education has become a self-perpetuating *social* [italics added] phenomenon." The vicious circle would be broken when "people with good ideas, different ideas, exciting ideas will no longer be faced with a dilemma where they have either to 'sell' their ideas to a conservative bureaucracy or shelve them." (p. 37). I saw the social penetration of computers as eventually providing individuals or communities with the instruments to develop and to implement new educational ideas. It takes the next 150 pages of the book for me to develop a rather complex example of such an idea that I call a "LOGO environment." I suggest that the penetration of computers into everyday life

> I do not present LOGO environments as my proposal for doing this. They are too primitive, too limited. The role I hope they fill is... an object-to-think-with, that will contribute to the essentially social process of constructing the education of the future,... there will be more tries, and more and more. And eventually, somewhere, all the pieces *will* come together and it will "catch." (p. 182)

and dissatisfaction with traditional school can (sic ... not will) come together in the construction of educationally powerful environments and then say:

I describe in *The Children's Machine* how surprised I was to find that many thousands of people -- mainly visionary teachers -- found in this book an articulation of their desire for something different from School. Many of them tried... and tried. Many burned out. Many were defeated by the bureaucracy of School. Many are still trying. The most insightful of those who are teachers working in conventional schools understand what they are doing today in the same spirit as my remark about my early LOGO environments not being the ideal they wish for, or even an approximation to it. As ideas multiply and as the ubiquitous computer presence solidifies, the prospect of deep change becomes more real. Their day-to-day work with computers will be the seeds from which it will grow.

I feel honored and flattered by the good things Tim O'Shea writes about me in his review of The Children's Machine, but am all the more surprised by his falling for the belief that Roy Pea could be held to have "evaluated" the vision presented in *Mindstorms*. The strongest negative conclusion that could in principle be drawn from one experiment that has children "doing LOGO" for a few hours a week in their otherwise unchanged school culture is that a particular implementation of a very primitive early form of the LOGO idea failed to "work" according to a particular measure of success (and in Pea's case one that I would have regarded as a measure of failure had it, in fact, shown significant change). Tim Koschmann's review of my book suggests two more optimistic reactions to Pea. One he makes explicitly: Learn from the failure and try again. The other is implicit in his comparison of LOGO with Latin.

Two Senses of "Latin"

Koschmann's comparison of LOGO with Latin focuses on the issue of transfer of cognitive skills from programming to other areas of intellectual activity. I agree completely with the soundness and importance of his conclusion that what is needed here is richer study of the cultural context of transfer. On that issue I would just add one observation. Psychologists have studied transfer as if it were something that happens to you; I look at it as something you do, and am especially interested in the development of cultures that give transfer the status of a deliberate act.

I also like Koschmann's title for its suggestion of a connection between LOGO and an altogether different erstwhile function of Latin. In recent times, Latin was taught in schools because it was supposed to be good for the development of general cognitive skills. Further back, it was taught because it was the language in which all scholarly knowledge was expressed, and I have suggested that computational language could come to play a similar role in relation to quite extensive areas of knowledge.

The shift in the treatment of the parabola mentioned earlier is typical of examples developed in *Mindstorms* and in *Explorations in the Space of Mathematics Educations* of how knowledge can become far more accessible and far more learnable, when couched in computational language. I am sure that in the course of time this greater ease will result in a Darwinian evolution of mathematics education. Similar to biological evolution it will take time, and it is worth the risk of a little repetition to review some of the factors that militate against quick change.

The Content of Change and the Change of Content

The key point is that many components of the system have to change and in a matched way. Introducing the suggested new treatment of the parabola into a school without computers would quickly prove that it is hopelessly bad. Even putting in a lot of computers would be insufficient unless the conditions were present for the students to acquire fluency in a suitable computational language. This would require time. Again, time would not be sufficient. To learn French you certainly need time, but you would not learn it well unless you had the opportunity for engaging talk or reading in French. In the case of the parabola, if this were all that was available to the students of the new language they would be no more likely to show success in learning than students of French who had access to one short passage in that language. For success, there would have to have developed the analog of a diverse collection of books written in French and access to French-speaking people.

The central issue is analogous to one that has played a central role in theories of biological evolution: How do features of the system whose functions are mutually dependent come into being without a guiding designer? Attempts to change the medium and leave the content (e.g., use computers to teach the same math) or change the content but keep the medium (eg., National Council of Teachers of Mathematics standards or "The New Math" performed in the old medium) do not create a new equilibrium -- in fact they make a "camel" in the sense of "a horse designed by a committee." Nobody is satisfied with the camel and the system snaps back to the old equilibrium, manifesting as it does so the mechanisms so brilliantly described by Tyack and Cuban.

In his review, O'Shea puts his finger on one strategy to deal with this problem when he refers to the need to develop content that embodies the LOGO vision and yet can be used within School curriculum. I have to agree with him: Although I, and a few others, have done some work on this "Trojan Horse" strategy, much more is needed. I hope he will be pleased to note that my recent work (Papert, 1996b) marks an intensification of this effort as does a publication in preparation that gives a more curriculum-like and more substantive development of the material in the chapter on cybernetics in *The Children's Machine* (5).

Reformulating knowledge in the "new Latin" while at the same time developing the language and creating conditions for children to learn is formidable enough as a research program, but I believe that even this would not be enough to create a new equilibrated system. Changes would be needed in other components in addition to content and medium. One that is nicely picked up by Koschmann and, I am afraid, seems to be entirely missed by O'Shea is epistemological style. The style I call bricolage (following Levi-Strauss, Robert Lawler, and my own work with Sherry Turkle) fits the learning styles of many or most children but is powerfully at odds with School's style. The point missed by O'Shea's comments is that the chapter of *The Children's Machine* on cybernetics is really about how to introduce into a curriculum for children an area of knowledge that allows work in a bricolage style to support an entry into rigorous mathematics and science. The deeper point is to offer an example showing a different content, different style of learning, different epistemology, and a different medium all matched to one another and to a form of school structured without curriculum or age segregation.

My apparent failure to make the intention of that chapter clear enough lies behind another of O'Shea's comments with which I agree completely in principle. He writes: "We now need an account of how, for example, the innovative work of Mitchel Resnick on computational construction kits may relate to and support school learning" (p. 405). But the intention of the chapter called "Cybernetics" was to sketch informally some aspects of one way to do exactly that. Work on what my colleague Mitchel Resnick calls computational construction kits is an integral part of the further development by the team we jointly lead at the Massachusetts Institute of Technology Media Laboratory of the vision that began with the early work on LOGO. We are busy doing what O'Shea recommends. Readers who are interested in following this ongoing development should keep in touch with the publication list of the Epistemology and Learning group at the Media Lab via its World Wide Web site (see Footnote 5).

Darwin Versus the Gosplan

In conclusion, I use a political metaphor to express my most profound points of agreement and of disagreement with Tyack and Cuban. Designing an alternative education is a Soviet-Gosplan-like enterprise whose ultimate fatal flaw is what made the Soviet system impossible. Tyack and Cuban spell out in the case of School reform how centralized social engineering inexorably goes wrong. Complex systems are not made. They evolve. Where I part company from Tyack and Cuban is when they turn from the book's historical theme of showing that reform will not work to give advice to reformers about how to do it better. My own view is that education activists can be effective in fostering radical change by rejecting the concept of a planned reform and concentrating on creating the obvious conditions for Darwinian evolution: Allow rich diversity to play itself out. Of course, neither of us can prove the other is wrong. That's what I mean by diversity.

Footnotes

(1) The capitalized word "School" refers to an idealized theoretical entity of which actual schools are more or less approximate representatives. In using it, I am asserting (a) that despite a real degree of individual difference, it is useful to treat schools on the whole as essentially the same, and (b) that despite a real degree of autonomy, the dynamic of how schools responds is best seen as the response of a system or an institution that transcends the individual school.

(2) Dennett (1994) agrees with creationists that life and the Universe must have been designed by developing a naturalized version of the concept of design as an algorithmic process with no need of a designer.

(3) Accounts of Piaget often forget that the motivation for the stage theory is a recognition of the need for development to stand still long enough for new structures to consolidate.

(4) I see the treatment of Edison's remark as the low point of the book. In the literal sense, in which it seems to be used here, the remark is just silly. Devoting space to it ridicules people who believe in educational technology. But in a deeper sense Edison is surely right -- the printed textbook is being displaced by electronic publications.

(5) The interested reader can track this activity on the World Wide Web at www.media.mit.edu.

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