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The following three articles are responses to Seymour Papert's article "Computer Criticism and Technocentric Thinking," which appeared in the Information Technology and Education column of the January-February 1987 ER.

The new coeditor of the Information Technology and Education column is Dick Clark, School of Education, 801 WPH, University of Southern California, Los Angeles, CA 90089-0031. Gavriel Salomon is continuing as coeditor; his address is College of Education, University of Arizona, Tucson, AZ 85721.

The Aims of Software Criticism: Reply to Professor Papert

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Professor Papert (1987) has presented a case for developing a discipline of computer criticism, with aims similar to literary criticism. He suggests that computer criticism may help us understand computation as a medium of human expression. I believe such a field is a great idea and that its investigations could yield fundamental insights into the nature of mind and society, and their relation to computational media. Contributions to the field of literary criticism have had major influences on the nature of inquiries in history, anthropology, linguistics, psychology, and the philosophy of science (e.g., Baynes, Bohman, & McCarthy, 1987; Bernstein, 1983). There are certainly other active fields devoted to criticism in architecture, art, culture, film, music, photography, theater, and aesthetics more generally that have proven illuminating in similar respects.

The field of *computer* criticism Papert recommends is perhaps not aptly named. *Software* criticism is more at issue than the computer itself, much as one critiques texts and rarely the implements of writing. One might also distinguish criticism about software-in-general as a medium of expression versus specific software programs, analogously to critiques of written language as a medium of expression (e.g., Ong, 1982) versus specific documents such as *Finnegan's Wake*.

But I will argue that Papert gets this new field off to a bad start by proclaiming that there are "developmental stages" of criticism, by suggesting eradication of developmentally less-advanced criticism (what he calls "technocentrism"), and by misattributing technocentric beliefs to certain authors even as his own writing has encouraged what he would apparently now describe as technocentric thinking. He also dismisses the need for experimental research in building "computer cultures," even as he makes comparative quality statements that require research support. My remarks address these faulty premises, in the spirit of moving toward a better understanding of the issues and problems this discipline of software criticism may present.

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There Are Not Stages to Computer Criticism

Papert defines *technocentrism* as the tendency to give a centrality to a technical object such as Logo or computers, which "shows up in questions like 'What is THE effect of THE computer on cognitive development?'." Such talk "betray[s] a tendency to think of 'computers' and of 'Logo' as agents that act directly on thinking and learning," reduc-

ing people and cultures to a supporting secondary role (1987, p. 23).

Papert goes on to propose, by analogy to Piagetian developmental stages, that computer criticism is "blocked at a stage. . . properly called *technocentric*" (1987, p. 23). *Technocentric* is thus defined as a developmentally less advanced form of criticism—it is used as analogy to *egocentric* in Piagetian terms. The child ("critic") has difficulty understanding anything independently of the self ("technical object").

But the Piagetian analogy is invalid. Although Papert notes that he is able to recognize evidence in a classroom for when "the computer culture matures" (1987, Note 2, p. 30), one might ask: On what conceptual or empirical foundations do his criteria for distinguishing the growth of computer culture stages depend? Presumably not from longitudinal studies of such cultures. These value issues arise repeatedly throughout Papert's article (1987). Papert characterizes his own critical perspective on these issues as privileged, as "serious criticism" (1987, p. 28).

There is also a vast, unwarranted leap from computer uses Papert considers "beautiful" to those that have "cultural importance" (1987, p. 28). Such presumed "developmental" judgments are fatally flawed because criticism is not like such classical Piagetian "stage" phenomena as conservation of number. The use of comparative methods of evaluation in literary criticism and the philosophy of science (e.g., see reviews in Eagleton, 1983; Mitchell, 1983) indicates that a stage theory of criticism of any kind is question-begging, since the criteria of evaluation derives from a specific paradigm. A controversial question is begged if one defines a problem in a self-interested way such that the correctness of one's proposed solution is guaranteed by the problem definition.

A comparison with literary criticism will make the danger of such developmental analogies evident. What would it mean to say that literary criticism is blocked at the "textocentric" stage? Whereas it is true that I.A. Richards half a century ago was probably the last major literary critic to place most of the meaning in the text, or in the author's intentions, the advent of different literary critical perspectives such as structuralism, deconstructionism, feminist criticism, or reception theory in subsequent decades did not make them "better" because they came about later. "History," as many analyses have made evident, is not "development." Development is a value concept, not an empirical one (Kaplan, 1983; Nisbet, 1980), and value claims cannot be established by fiat. A contemporary critic would find it hard to get away with claims that literary theories are "less developed" if they take the text, rather than, for example, reader response or communities of interpretation as central to understanding written expression.

Papert's judgment that technocentrism is developmentally primitive is deeply evident in the "disease" metaphor that he uses to describe it (1987, p. 24; emphases my own). Here the developmental analogy turns pernicious. He uses a medical model, stressing that technocentric ideas are hidden, to be uncovered, and that we must focus on the "diagnosis of technocentrism" in the language of computer critics, which can be "confirmed" like a disease by careful "examination." We thus learn not only that the technocentric critical perspective is at a developmentally primitive stage, but that it must be found out and overcome. It would be very hard indeed to mistake talk of purge—of "combatting technocentrism," even "eliminating technocentrism" (1987, p. 23)—as the computer counterpart of literary criticism. Literary critics may be a contentious lot, but they are not often taken seriously if they proclaim that the beliefs of others are disease-ridden. Shades of the Inquisition.

Another maligning metaphor is slipped in as well: technocentrism as evil trap. Even humanists, we learn, are "often the most vulnerable to the technocentric trap" (1987, p. 23). To conclude this parade of negative rhetorical tones, Papert also compares technocentrism to sexism (1987, p. 23).

What are we to make of these tirades? I actually agree with Papert that technocentrism is not a fruitful critical perspective, and that issues of cultural and individual interpretation of software, and actual patterns of use, are a central aspect of understanding human-computer relations. But I dissent from the practice of dismissing technocentrism by fiat rather than debate.

Furthermore, it is not unreasonable to ask whether anyone but a straw person actually holds the technocentric beliefs that Papert describes. I am doubtful. One reason is that the computer and Logo are each relatively new in the history of education, and the well-known "given-new" convention of natural language pragmatics reveals that people tend to talk about what is new rather than what is given. Thus people may be talking about the effects of "computers"—the core, object-centered feature that defines technocentric criticism for Papert—not because the computer is *all* that they are considering, but because it is the most obvious thing to them that is *new* in education. Perhaps technocentrism is but an epiphenomenon of such discourse conventions, and not a result of insidious theorizing.

Where Did Techocentrism Arise, Anyway?

But let us assume for the sake of argument that technocentrism is a real perspective. Perhaps the greatest irony in the prolonged assault on those who would be technocentric is that this attitude is encouraged—at least by phrases of the kind we are supposed to be on the lookout for—throughout *Mindstorms* (Papert, 1980), particularly in Chapter 1:

> Looking at the effect of working with computers on two kinds of thinking Piaget associates with the formal stage of intellectual development [p. 21]; I am essentially optimistic—some might say utopian—about the effect of computers on society [p. 26]; The central open questions about the effect of computers on children in the 1980's are. . . [p. 29].

It is hard not to also characterize these statements as evidence of "the absurdity of the technocentric question 'What is THE effect of Logo?' " (Papert, 1987, p. 25).

Of course Papert (1980) tempered

his talk about the effects of computers on children around these quotes with discussions of cultural influences on such effects. But the important point is that so have those whose work he labels as technocentric.

Papert alludes to Bank Street studies of Logo programming and thinking as technocentric (1987, pp. 24, 26). But the arguments he presents—"Pea and Kurland are negative...about what happens when children learn Logo" (1987, p. 26)—are not even a critique of that work on its own terms. References are not cited so that readers could determine their own response to this empirical literature. If any one activity can be prescribed for computer critics, it is that they should read the primary works of the authors or critics they critique, not popular secondary sources such as *Psychology Today*, whose interpretation of our studies gave Papert a "springboard" (1987, p. 27) for his critique. Literary critics do not exclusively rely on the interpretive literature, much less that reported in the popular press (which is subject to its own given-new contracts to "report what's new").

The theoretical perspective and findings of our research programs on cognition and programming cannot be reviewed here. But a few illustrations may suffice. Pea and Kurland (1984; also Pea & Kurland, 1983) highlight the importance in programming not only of the technical environment but of specific activities in the teaching and cultural environment, not "programming-in-general" (Papert, 1987, p. 27), which was never our emphasis. Pea (1984) provided discussions at the MIT-Logo Conference on the relevance of anthropological data to cultural conditions for learning thinking skills through Logo. Hawkins (in press) observed the importance of the Bank Street teachers' interpretations of Logo for what activities were carried out with Logo, and empirical reports from the Bank Street research make appropriate provisos on cultural context for interpreting our experimental results in Logo studies (Kurland, Pea, Clement & Mawby, 1986; Kurland, Clement, Mawby & Pea, in press; Pea, Kurland, & Hawkins, 1985).

In fact, it was the surprising negative results of our Logo experiments (finding no transfer of problem-solving skills such as debugging, planning, and procedural reasoning to nonprogramming problems by programmers) that led me to develop a sociocultural theory of knowledge transfer with relevance to computing in education (Pea, 1985b; Pea, in press-b), and to a sociohistorical perspective on the reorganizational roles of technologies in developing new "functional systems" of thinking (Pea, 1985c; Pea, in press-a; Pea & Kurland, in press). But unlike Papert, I believe such cultural changes are amenable to experimental investigation, even as a kind of "pulse taking" to see where changes underway are leading, so that (as in the case of Logo) if "bugs" arise in the acculturation process (e.g., teachers find it difficult to teach programming as a model for thinking, or students find it difficult to learn about how to think procedurally outside the programming environment), they can be addressed through new cultural practices.

Research Is Needed for Re-Making Education

Papert also claims that educational activism and experimental research are "radically incompatible" (1987, pp. 22, 26). This is a remarkable dichotomy, a narrow construal of what constitutes experimental research, that belies the practices of educational innovation and social science. Papert caricatures experimental methodologies and design as limited to the "treatment model." One can also do multivariate instructional experiments in which many cultural features change without "keeping everything but one factor" constant. The logic of such multivariate methodologies, widely used in sociology and educational research, involves comparing performances of different groups to test for complex links between prior experiences, including those of social change, and changes in individuals' performances or beliefs (e.g., Inkeles & Smith, 1974; Scribner & Cole, 1981).

Research has to begin specifically, and aim to turn speculations of what is good or flawed in an educational practice into specific research questions; a research enterprise develops as it asks more refined questions. Many studies on progressive education and inquiry education take this approach, not relinquishing the benefits of experimentalism along the way. And there are many studies of the impacts of specific uses of the computer on society and work. One may also point to cross-cultural studies of the cognitive consequences of literacy practices in contrast to schooling practices in the multiple regression analyses central to the African studies of Scribner and Cole (1981).

It is worth observing that Papert even needs experimental research to support his own agenda of promoting "appropriate" uses of Logo in schools—for how else are they to be distinguished from the inappropriate ones other than by their "feel"? He notes that "some of the seemingly very small differences between versions [of Logo] can make a difference" (1987, p. 27), but on what grounds, without measurement activities of some kind, will he know how much difference in a version of Logo makes a difference in what can be effectively done with such tools in education? Papert's ambivalence about experimental research is evident throughout *Mindstorms* and the 1987 paper. He decries it but is not able to avoid making claims that are testable only by means of such research. For example, one may note the quantitative claims he wants to make (1987, p. 25) about the relative merits of using Logo for inquiry activities on conceptual issues regarding clocks: the computer "extends the range of what the students can do...somewhat more than the others [materials] do...it gave rise to more concern with calibration and more interest in concepts like calibrating by averaging over many cycles." He wants to be able to compare the effects on mathematics learning of the design tradeoffs involved in different versions of Logo (1987, pp. 27–28). And he even welcomes experimental research on Logo classrooms if its outcomes fit his desires; for example, he likes the

Clement and Gullo findings that use such methods but not the work of Pea and colleagues.

One reason for the importance of experimental research is that, as a cultural building material, surely Logo, like any medium, has *some* limits. Could it really be equally good for everything? Isn't Logo but one medium, even of computational expression, whose appropriateness or superiority (as often claimed) for particular educational purposes remains an hypothesis to be examined empirically on a case-by-case basis? The same point applies to uses of other symbol systems, including logics, written languages, and other programming languages.

Setting the Record Straight on the Bank Street Studies

On several occasions Papert has implied or stated that teachers involved in the Bank Street Logo research were not skilled, and that the appropriate learning environment was not presented for looking at what children were learning. Only some of the needed clarification may be offered here.

Many people are unaware of how precious an environment the Bank Street School was for experiments on children's Logo learning. Teachers and researchers alike were enthusiastic in beginning the Logo project and were devoted to its success. Bank Street School has been a laboratory school at Bank Street College for 70 years. The institution was founded in 1916 by Lucy Sprague Mitchell as the Bureau of Educational Experiments, and was deeply influenced by John Dewey's child-centered pedagogy embodied in his laboratory school and by his progressivist writings linking school and society. Even today the social studies core of the school curriculum at Bank Street weaves together mathematics, science, and language arts in problem-solving contexts that display their functional connections to human purposes and activities.

So this school setting was a very fertile environment for receiving what were perceived to be the many compatible ideas expressed in Papert's progressivist text, *Mindstorms* (1980). In fact, we were often cautioned at the outset of our project that no one would believe positive findings demonstrating Logo's influences on children's thinking, because the classrooms were so unrepresentatively well-matched to the Logo pedagogy (as compared to most American schools), which stresses discovery-learning and student-planned project work. And the school was said to be highly unrepresentative in a second, positive direction: It was very computer-saturated for its time (1981–83: each of two classrooms had six computers for each of its 25 children), equipped with skilled and devoted progressive educators, and thus represented a receptive culture for helping students build their thinking skills with Logo. Two teachers from the school participated in Logo training planned and organized by Papert, who was also an early advisor to the project.

It was to the surprise and consternation of all involved that children and teachers began to have difficulties in making headway with the discovery-oriented vision for Logo in the ongoing classroom activities of children. And contrary to the negative portrayal of the Bank Street studies in Papert (1987) and elsewhere, the work did not end there. Many efforts were made in research and development activities to improve the quality of children's Logo learning, and to identify specific conceptual difficulties children encounter in learning to program and think with Logo (Kurland & Pea, 1985; Kurland, Pea, Clement & Mawby, in press; Pea, 1984; Pea, 1985a; Pea, Soloway & Spohrer, 1987). We certainly did not keep down other change (Papert, 1987, p. 26) so as to hold the effects of Logo "constant," as suggested by Papert's distorted portrayal of the treatment model of experimental research in education. We knew and said, even in our research proposal for funding our Logo research, that *many* things in the classroom context would change as a result of introducing Logo and accompanying activities. Our research and that of others since has helped clarify some of these changes, although much work remains to be done.

Conclusions

Papert often says that the main task for educational theory and technology is "the enterprise of rebuilding an education system in which nothing shall be the same" (1987, p. 22). But surely there are many possible scenarios for the ways in which education systems will be different. (And let's also hope that *something*—the centrality of the child's empowerment and realized potentials—shall be the same.) Should any imaginable technologically supported vision for education have the same free reins that Papert recommends for Logo? One in which the implementation of a pedagogy has no accountability to experimental research? In which culture-building is the only legitimate activity?

Responsibility for designing the future of education cannot rest in any single vision. It cannot be given unbridled freedom from at least formative assessment en route to projected goals for a specific kind of learning society. We must listen to the community of voices from children, teachers, and researchers who find innovation—technological or otherwise—more or less amenable to their ways of thinking and living in the world. The lived situation, as Maxine Greene calls it, must have a certain primacy. It is too much to ask for all to wait for the day of "completion"—when a proposed culture of learning environments saturated with technology is "built" and teachers and peers are equipped as Papert hopes—to ask the hard questions about the value of what is happening, and for what purposes, and with what trade-offs. There are undoubtedly risks in the reverse direction—of premature abandonment of good ideas from misinterpretations of ill-conceived, or even well-conceived, experimentation—but that is why there is a critical community. Readers and writers, actors and experimenters, voice their beliefs and arguments as they collectively establish the checks and balances appropriate to defining the aims and methods of our emerging education. The aims of software criticism should embrace such pluralities, not deny them.

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