Computer Criticism vs. Technocentric Thinking

By Seymour Papert

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critic (from Greek *kritikos* able to discern or judge)

1: one who expresses a reasoned opinion on any matter involving a judgment of its truth value or righteousness, an appreciation of its beauty or techniques, or an interpretation...
2: one given to harsh or captious judgment.

-Webster's Collegiate Dictionary

...the critic may on occasion be called upon to condemn the second rate and expose the fraudulent: though that duty is secondary to the duty of discriminating praise of what is praiseworthy.

-T.S. Eliot

In the beginning, criticism is simple. Do I like it? My judgment is personal and intuitive. I answer to myself alone, and consider only the immediate object of my attention. Soon, however, something more is needed; taste must be justified. Others challenge our opinions and counter with their own, and even personal development eventually requires us to grapple with our reasons.

The LOGO community faces the challenge of finding a voice for public dialogue. Where do we look? There is no shortage of models. The education establishment offers the notion of evaluation. Educational psychologists offer the notion of controlled experiment. The computer magazines have developed the idiom of product review. Philosophical tradition suggests inquiry into the essential nature of computation.

Each of these has intellectual value in its proper place. I shall argue that this proper place is a conservative context where change is small, slow, and superficial. The crucial experiment, to take one example, is based on a concept of changing a single factor in a complex situation while keeping everything else the same. I shall argue that this is radically incompatible with the enterprise of rebuilding an education system in which nothing shall be the same.

I would like to propose a very different model for thinking about the dialogue between LOGO and the world. This model is a department of thought that adopts the adjective "critical" in Webster's first sense. I am proposing a genre of writing one could call "computer criticism" by

analogy with such disciplines as literary criticism and social criticism. The name does not imply that such writing would condemn computers any more than literary criticism condemns literature or social criticism condemns society. The purpose of computer criticism is not to condemn but to understand, to explicate, to place in perspective. Of course, understanding does not exclude harsh (perhaps even captious) judgment. The result of understanding may well be to debunk. But critical judgment may also open our eyes to previously unnoticed virtue. And in the end, the critical and the creative processes need each other.

...the large part of the labor of an author in composing his work is critical labor; the labor of sifting, combining, constructing, expunging, correcting, testing; this frightful toil is as much critical as creative....

- T.S. Eliot

Computer criticism is in its infancy compared with the sister disciplines I imagine it emulating. Many would argue that it must always remain at best a lesser sibling since the objects, computational ones, on which it brings to bear its critical powers will never, in their opinion, have the stature of Shakespeare or the depth and complexity of social structure. I think history will gainsay this attitude. The computer is a medium of human expression and if it has not yet had its Shakespeares, its Michelangelos or its Einsteins, it will. Besides, the complexity and subtlety of the computer presence already make it a challenging topic for critical analysis. We have scarcely begun to grasp its human and social implications.

In this paper, I shall be concerned with issues closer to earth: not with the highest reaches that computer criticism may someday attain, but with its daily practice here and now: with how people talk about computers when they argue such practical matters as policies for using computers in schools or the value of a new piece of software. Within this already restricted purpose, I shall concentrate on just one proposition: I believe that computer criticism is blocked at a stage that I think is properly called *technocentric* -- a term that captures an analogy with the egocentric stage in Piaget's model of the young child.

Egocentrism for Piaget does not, of course, mean "selfishness" -- it means that the child has difficulty understanding anything independently of the self. Technocentrism refers to the tendency to give a similar centrality to a technical object -- for example computers or LOGO. This tendency shows up in questions like "what is *the* effect of *the* computer on cognitive development?" or "does LOGO work?" Of course such questions might be used innocently as shorthand for more complex assertions, so the diagnosis of technocentrism must be confirmed by careful examination of the arguments in which they are embedded. However, such turns of phrase often betray a tendency to think of "computers" and of "LOGO" as agents that act directly on thinking and learning; they betray a tendency to reduce what are really the most important components of educational situations -- people and cultures -- to a secondary, facilitating role (1). The context for human development is always a culture, never an isolated technology. In the presence of computers, cultures might change and with them people's ways of learning and thinking. But if you want to understand (or influence) the change, you have to center your attention on the culture -- not on the computer.

One might imagine that "technologists" would be most likely to fall into the technocentric trap and that "humanists" would have a better understanding of the role of culture in the so called

"effects of the computer." But things are not so simple. People from the humanities are often the most vulnerable to the technocentric trap. Insecurity sometimes makes a technical object loom too large in their thinking. Particularly in the case of computers, their intimidation and limited technical understanding often blind them to the fact that what they see as a property of "the computer" is often a cultural construct.

I am not talking about simple misunderstandings that could be dispelled by a course on "how computers really work." You should rather think of the way sexist or racist stereotypes are rooted in, and supported by, the cultures in which we grew up. Computer stereotypes are as much cultural constructs as are stereotypes of women or blacks, and will be as hard to extirpate.

The struggle against sexism went far deeper than correcting erroneous beliefs about women. It has led to a re-examination of fundamental assumptions about human nature and about society. Combating technocentrism involves more than thinking about technology. It leads to fundamental re-examination of assumptions about the area of application of technology with which one is concerned: if we are interested in eliminating technocentrism from thinking about computers in education, we may find ourselves having to re-examine assumptions about education that were made long before the advent of computers. (One could even argue that the principal contribution to education made thus far by the computer presence has been to force us to think through issues that themselves have nothing to do with computers.)

What LOGO Practitioners Need to Know

If you ask, "What does a LOGO practitioner need to know?" the answer goes beyond the ability to use and teach LOGO. The practitioner needs to be able to talk about LOGO, to criticize it, and to discuss other people's criticisms.

Talking about LOGO has a political side: how do you reply when an administrator says he read in *Psychology Today* that "LOGO doesn't work?" It has a pedagogical side: LOGO is at a stage where one very high priority is to talk critically about a first implementation in order to decide where to go next.

And talking about LOGO has a culture-building side. The way a teacher talks to parents about LOGO feeds back into the attitudes the child brings to class, and the way the teacher talks in class influences the talk about computers in the living room. The popular interest in computers gives every teacher the opportunity to influence the development of the "computer culture" not only in the school but also in the society at large. Taking that opportunity is part of teaching -- or at least of what teaching ought to be. Developing a discourse is at the heart of developing a culture, and a more textured and knowledgeable discourse about LOGO contributes to the "LOGO culture," the "computer culture," and to the "learning culture" in its broadest sense. It sets the cultural context for personal learning.

Finally, a more self-conscious discourse will help the LOGO community become increasingly self-critical; not, by any means, to put itself down, but because, like Eliot writing poetry, we need well-honed critical thinking to carry out the "frightful toil" of responsible educational creativity. I don't think any of us is safe from falling into occasional technocentrisms. What is important is

having a set of concepts that allow one to correct oneself -- and then having the sense and humility to do so.

LOGO Didn't Deliver What It Promised

The following discussion of a "poor way" to talk about LOGO will sharpen these remarks by making my point about the pitfalls of "technocentrism" more concrete.

The September 1984 issue of *Psychology Today* featured articles on computers and education. In one of these (by James Hassett), we read:

"In several studies comparing children who learned LOGO with control groups who did not, researchers at Bank Street College's Center for Children and Technology have been surprised to find that, as Jan Hawkins put it, 'LOGO promises more than it has delivered.' ... Bank Street researcher Roy Pea found no evidence of intellectual benefits on two planning tasks designed to measure higher levels of thinking skill supposedly produced by LOGO learning."

It would be frivolous to dwell on what the reference to promises and delivery evokes for me: the image of a technological "fix"-- the image of LOGO driving a delivery truck loaded with crates of promises. But it is far from frivolous to examine what is presupposed and implied by treating "LOGO" as an entity that can "produce" changes in thinking (or anything else!) "Does LOGO work?" "Is LOGO good for learning this or that?" All these turns of speech are signs of the technocentric stage of computer discourse.

Consider for a moment some questions that are "obviously" absurd. Does wood produce good houses? If I built a house out of wood and it fell down, would this show that wood does not produce good houses? Do hammers and saws produce good furniture? These betray themselves as technocentric questions by ignoring people and the elements only people can introduce: skill, design, aesthetics. Of course these examples are caricatures. In practice, hardly anyone carries technocentrism that far. Everyone realizes that it is carpenters who use wood, hammers, and saws to produce houses and furniture, and the quality of the product depends on the quality of their work. But when it comes to computers and LOGO, critics (and some practitioners as well) seem to move into abstractions and ask "Is the computer good for the cognitive development of the child?" and even "Does the computer (or LOGO or whatever) produce thinking skills?"

As I already said: such language suggests a diagnosis of technocentrism. To confirm it, one has to look more closely at what lies behind the language. This I shall do from several perspectives in the following discussion. For the moment I note one. Technocentrism is often supported by a certain model of what a "rigorous" experiment in educational psychology consists of. I'll call this "the treatment model."

You take two groups of children. One group, the experimental group, is given a certain "treatment." (For example, these students are taught LOGO.) The other group, the control group, is not given the treatment. Everything else is kept constant. After a suitable lapse of

time you come back and apply a test to see whether the particular thinking skill that interests you is better developed in the experimental group than in the control group.

There is nothing wrong in principle with this "treatment" model. Some very good science is based on it. It is the standard model for testing medical treatment by drugs -- hence its name -- and, indeed, some very good support for LOGO has come from it. For example, Clement and Gullo at Kent State University (Clement & Gullo 1984) used it skillfully to show that certain cognitive and metacognitive skills developed significantly better in a group of children who worked at LOGO than in a control group who worked at computer-assisted instruction (CAI). But the use of the model requires care, and technocentrism places unskilled users at risk.

The risk is greatest in the interpretation of negative results. If you need to know whether drug X reduces blood-pressure, you may fairly safely draw a negative conclusion from a "treatment model" experiment in which hospitalized patients were given X and no change in blood-pressure was observed. On the other hand, you would not deduce that drug Y does not increase fertility from the simple fact that hospitalized patients who received it had no babies. You would want to know more about other conditions that are known to be necessary. Nor would you deduce that ice is a bad material for building dwellings if you heard that I tried to build an igloo in Boston in mid-summer and failed. The right environment and, I presume, a high degree of special skill are necessary. Such a failed experiment would say much more about me than about whether "igloos deliver what they promise."

It is quite surprising that Hassett thinks that Pea's findings (e.g. Pea & Kurland 1983) say more about LOGO than about Pea. The experiment was based on a treatment model with negative results: children given LOGO failed to show significant improvement on a particular test for cognitive change. Thus we know the experiment is at risk. Enter technocentrism. Pea's negative result is moderately compelling if you believe that LOGO is a well defined entity (like drug X) that either has an effect or does not have an effect (the technocentric vision). However, the finding as stated has no force whatsoever if you see LOGO not as a treatment but as a cultural element -- something that can be powerful when it is integrated into a culture but is simply isolated technical knowledge when it is not.

My analysis of Hassett's technocentric language illustrates the value of the idea of technocentrism, for it can explain, at least partially, the quite extraordinary fact that Hassett, and many others as well, seem willing to make so much of a very slim experiment on the effects of learning LOGO. But to pursue the point, I have to develop the contrasting idea of LOGO as a cultural element.

An Example of LOGO as a Cultural Building Material

I choose a simple example of LOGO being used as a "cultural building material" by a teacher trying to create a particular educational culture in his science classes at the Computer School, an alternative public junior high school in New York City's School District Three. George Franz, one of the school's two science teachers, has intellectual roots in the tradition of "open education" represented by such people as Lillian Webber (under whom he studied directly) and David Hawkins. The spirit of this tradition is captured in a paper by Hawkins (Hawkins 1965),

marvelously entitled "Messing About In Science," in which he describes how he and Eleanor Duckworth introduced children to the study of pendulums by encouraging them to "mess about" with pendulums for a number of class hours that would horrify teachers who measure the efficiency of education by how quickly students get to "know" the "right" answers. But Hawkins was interested in more than right answers. He had realized that the pendulum is a brilliant choice of an "object to think with" (to use the language of *Mindstorms* [Papert 1980]) for building a sense of science as *inquiry* rather than as answers.

A mechanical (and to my mind trivial) way to meld the computer into Hawkins' kind of learning experience would be to provide computer simulations of pendulums. Franz did something much more subtle. His idea was to get his classes engaged in "messing about with clocks" by challenging them to build devices to measure time more accurately than such spontaneous methods as counting "one chimpanzee, two chimpanzees..." The students were encouraged to form small teams, each of which would build a clock defined for this purpose as anything that could measure time.

One enabling cultural factor here is that the science room at the Computer School is a good "messing place." It is like an old-fashioned science lab in being well stocked with string and sealing wax -- and bits of plastic and wire and hamsters and snakes -- as well as being like a modern one in being well supplied with computers. So when the students let their imaginations go, they find the odds and ends to make many kinds of clocks. One group worked with sand running out of a plastic container, several constructed some kind of pendulum device... and some made "clocks" in the form of LOGO programs. It is good to contemplate this coexistence of clocks made of ancient materials and modern ones: wood and plastic and computers. The computer was "just one more material." I think that David Hawkins would have liked what happened.

One does not "need" a computer to mess about with making simple clocks. But the students' clock experience was made very much richer by the fact that everyone in the class -- students and teachers -- knew enough LOGO and had enough access to computers to make computer clocks as well as clocks of sand and wood. Each different material extends the range of what the students can do, and the computer does so somewhat more than the others do. For example, it gave rise to more concern with calibration and more interest in concepts like calibrating by averaging over many cycles. It is more adaptable to using the same principle to measure very short intervals (human reaction times, for example) or very long ones. A computer clock could be adapted to measure the speed of model cars the students were building out of LEGO materials. In short, the presence of this additional material never took over the project -- the traditional materials retained their interest but greatly enriched the clock culture that grew up in the science room of that school without changing its nature. Since everyone knew some LOGO, even those who did not make their own computer clocks could understand those made by their classmates.

If LOGO contributed to the growth of the classroom culture, this clock culture contributed simultaneously to LOGO. Several students came to understand technical aspects of LOGO they had not learned before. For example, some who had previously resisted using variables asked "What was that thing with dots?" when they needed the idea to go from analog to digital clocks. I think all of them took another step towards appreciating LOGO and the computer in a way that seems to be beyond the comprehension of many educational psychologists: using the

computer not as a "thing in itself " that may or may not deliver benefits, but as a material that can be appropriated to do better whatever you are doing (and which will not do anything if you are not!) (2)

Two Educational Cultures

In school A (which I leave unnamed since I am neither personally in sympathy with its culture nor interested here in arguing against it), the students meet LOGO in a computer room (misnamed "lab") where each sits down in front of a machine and is taught what the school system's educational objectives describe as introductory programming: turtle commands, subprocedures, variables, recursion... and so on. The sequence is planned and orderly.

School A uses LOGO as part of a conservative educational policy. But it is innovative in how it does this. One local innovation, typical in spirit and ingenuity of several that have been invented or re-invented at this school, is the theory that computers should be so arranged that the students sit with their backs to the teacher's station. That way, when the teacher calls for their attention, they are forced to turn around -- away from any temptation to see their screen or fiddle with their keyboards. School A is innovative, but at a heading of 180 degrees to the kind of innovation we saw Mr. Franz making.

The absurdity of the technocentric question "What is *the* effect of LOGO?" becomes plain when one tries to imagine what is common to these two LOGO experiences. Both involve LOGO, both involve computers, and I am sure that one could devise tests to show that they share some very generalized educational consequences. That would satisfy the technocentric kind of education evaluator. Yet it would be sadly missing the point of LOGO. For the two educational enterprises have different goals and have used LOGO for quite different purposes. What is most important to each is *not* shared: they use LOGO not to become more alike, but rather to develop their individuality. In the end, each becomes more purely itself and so more distinctly different from the other.

The Right To Be Me

The principle that LOGO can be used by two schools to become more distinctly different has a counterpart on the level of the individual. In *Mindstorms* (Papert 1980) and in the Brookline Report (Papert et al. 1979), there are examples of students who use very different styles in their work with LOGO. But the idea of students appropriating LOGO in very different ways did not mature until we reached a point where children could have sufficient access to computers that their individual styles developed in more strikingly divergent ways than was possible in the more confined conditions of the early experiments. I became aware of something deeper than we had seen in early work while collaborating with Sherry Turkle on observations that are reported most "thickly" in her book *The Second Self: Computers and the Human Spirit* (Turkle 1984).

It will be recalled that what Pea's experiment failed to find was evidence "on two planning tasks" for the thinking skills "supposedly produced by LOGO." Hassett quoted this finding without asking who supposes that the thinking skills produced by LOGO would show up particularly well on "planning tasks." But the answer to the question he does not ask is easy to find: everyone knows that computer programming uses the kind of thinking one needs for planning -- precise, abstract, analytic descriptions.

The point is that this is the way our culture represents programming. But when we studied what children do with LOGO, we see a very different picture. Some do indeed fit the cultural stereotype. For them, work with LOGO is an occasion for the exercise of planning. But many do not. Many find in LOGO their first opportunity to work with mathematical ideas in the kind of broad-brush intuitive style that comes naturally to them. They are not led by LOGO into conforming to the planning style even more closely than school already tried to make them do. On the contrary, in LOGO they find a liberation from a style that distorts their natural way of being as surely as forcing left-handed children to use their right hands.

Pea's criterion for how LOGO is supposed to improve thinking skills implies that we should be disappointed to see these students find a different voice (3) for learning. This is a good example of the conservatism inherent in traditional experimental methodology.

Do Not Ask What LOGO Can Do To People, But What People Can Do With LOGO

These two questions lead to quite different models for how to do research. Technocentric thinking favors the "treatment" methodology. This is appropriate for investigating the effect of a drug. And if you read Inhelder and Piaget on formal stage thinking, or if you were taught "the scientific method" at school, you probably know that the way to do an experiment is to change one variable at a time while keeping all other things the same.

This works well for certain kinds of school science experiments, such as finding out how a pendulum's weight, length, and amplitude affect its period. But does it work for education? How do you apply this methodology if you are Geraldine Kozberg of the St. Paul Public Schools and want to use LOGO as an instrument for change?

Ms. Kozberg's initial interest in LOGO came from an intuition that introducing LOGO into the schools could be used as an occasion to bring about other changes -- not only in the way teachers did their work in the classroom but also in the relationship of the community to the school. The initial excitement about computers in the classroom could be used to bring parents to workshops; discussions would start off dealing with computers, but then move on to education as a collaborative endeavor.

This is the methodology of an educational activist. Instead of introducing LOGO and keeping down other change (which appears to the activist as subverting the very thing one is hoping to do), here one introduces LOGO and then works as hard as possible to make all other things as different as possible (which can appear to experimentalists as subverting as science).

The Computer School in New York's District Three (Upper West Side including West Harlem) gives us another example. This alternative public school is attended by about 150 students, many of whom come from severely disadvantaged backgrounds; during the school year, the computer presence grew in numbers from about 20 to 60 machines. The school's policy is that all students learn LOGO and the use of a word processor, but beyond this, the teachers adapt their styles of work very differently. Some have looked for ways to adapt method and content in their subject areas to take advantage of the computers. Others believe that advantages will come less directly and more gradually.

This is not a controlled experiment on "the effects" of LOGO. It is an attempt to create a working educational environment in which 60 computers and LOGO are important elements -- but so are nine teachers with nine personal approaches to education who are trying very hard by all possible means to make the school system a success.

The methodological issue comes into clear focus when we look at successes in areas having the least direct connection with "computer work." For example, the Computer School was significantly ahead of other schools with children from similar backgrounds on reading and attendance scores.

Psychologists trained in the "treatment" methodology have been taught to ask questions like: "How can we measure the extent to which LOGO contributed to these scores?" These psychologists repine for controlled experiments that will distinguish between the contributions of each of many possible factors. What experiment would tell us whether factors such as the teachers' enthusiasm (or attention from visitors, or the students' sense of getting something special) contributed to the high scores? But there is no need to wait for experiments: of course such factors play a significant role.

This does not mean that the computers were not important; rather, it reminds us that the importance of each element in a cultural process can show up in many ways. These teachers came together in the first place to create a school that would use computers in a LOGO spirit. Without the computers, the school would not have existed at all. Discussing, sometimes even fighting, about what to do with LOGO created a relationship between the teachers that colored the atmosphere of the school. So, I am sure, did the fact that everyone in the school knew that student X was, until this year, considered to be "learning disabled" but is now an ace with the computer -- this particularly dramatic example of someone who went beyond what seemed possible surely contributes to the atmosphere of the school. One could continue almost indefinitely to list ways in which the computer presence could be woven into the consciousness of the people in the school -- and so make a difference to how students learn and whether they want to come to school.

There is a radical incompatibility between studying phenomena of this sort and using the "treatment" method of research. A simple argument for this point is the incredible number of experiments one would have to do in order to isolate these factors one by one. But there is a deeper argument. Factors of this kind simply don't work one by one; they work as a web of mutually supporting, interacting processes. The illusion that more than a tiny fraction of the educational benefits could be demonstrated by experiments on the treatment model is simply another form of technocratic fallacy.

Let me express the same idea in a different way. It is a self-defeating parody of scientism to suppose that one could keep everything else, including the culture, constant while adding a serious computer presence to a learning environment. If the role of the computer is so slight that the rest can be kept constant, it will also be too slight for much to come of it. The "treatment" methodology leads to a danger that all experiments with computers and learning will be seen as failures: either they are trivial because very little happened, or they are "unscientific" because something real *did* happen and too many factors changed at once.

Bank Street vs. Kent State

My purpose here is not to survey good reports about LOGO. But I shall discuss one. One often hears that reports of good LOGO environments are "anecdotal." This word is used as a derogatory form of the adjective "ethnographic" and in contrast to a more "scientific method." I do not agree with the derogation of the case study approach, but even if one's taste runs to methodology which emphasize statistical rigor, there are other studies than those of Pea. For example, Clement and Gullo of Kent State University conclude from a careful and statistically orthodox study that a group of children who worked with LOGO showed significant improvement on a battery of tests designed to measure a range of cognitive skills.

Pea and Kurland are negative, Clement and Gullo positive about what happens when children learn LOGO. One can look at the difference from two sides -- analogous to the supply and demand sides of economic theory. The experimenters demand a certain performance from the students as a condition for success; and certain educational conditions are supplied to the students for the purpose of achieving this performance.

On the demand side, that is to say on the tests used, the experimenters are fairly explicit about their differences. Pea and Kurland approach their experiment with a very specific idea of what cognitive effect to look for: they are checking for an improvement in a very, narrow and specific form of planning activity, so they use a focused ad hoc test. The Kent State workers approach the problem with a relatively open mind about what the cognitive effects of doing LOGO might be: they apply a broad spectrum of well-known, standard tests of cognitive function (amongst many others: divergence, reflectivity-impulsivity, operational competence, right-left orientation, matching familiar figures, and following directions.) Even before one sees the results, it is obvious that the Kent State experiment stands a much higher chance of coming out positive as, indeed, it does.

The supply side is more subtle. What are the children given? Stated abstractly, the two studies have the same explicit intention: the children are to be given "programming"-- and the purpose of the experiments is to see what happens. But there is no such thing as "programming-in-general." These children are not given "programming." They are given LOGO. But there is no such thing as "LOGO-in-general" either. The children encounter LOGO in a particular way, in a particular relationship to other people, teachers, peer mentors, and friends. (4) They don't encounter a thing, they encounter a culture.

Both studies are flawed, though to very different extents, by inadequate recognition of the fact that what they are looking at, and therefore making discoveries about, is not programming but

cultures that happen to have in common the presence of a computer and the LOGO language. But the flaw is fatal only in the Bank Street case. I would be rather surprised (though pleasantly so) if the cognitive changes measured by Clement and Gullo turned out to be repeatable for all children in all encounters with LOGO. However, their study has added to the collection of serious reports about phenomena occurring in some LOGO environment. Perhaps it will lead to recommendations about how to design LOGO environments so that most children would experience the developments it reports. I cannot see how anything useful can be derived from the Bank Street finding that the children did not meet Pea's criteria of planning.

ExperLOGO: Designing a New LOGO

In the near future, LOGO practitioners will have a new kind of challenge in choosing among varied forms of LOGO. Up to now, the differences among the versions of LOGO available for the major educational computers strike many people as being able to choose any color as long as it is black. I believe that this is a mistaken view; some of the seemingly very small differences between versions can make a difference. But these are inconsequential compared with larger choices that will be presented as LOGO implementers take advantage of greater machine power.

In this context, I do not mean to speculate about what new directions LOGO will or should take. There certainly is no single "right direction" -- LOGOs will be varied and flexible. What I want to discuss here is how to discuss the choices that will be offered. And, once more, I shall concentrate on just one issue: the difference between technocentric thinking and a style of computer criticism that has learned to think in terms of cultural phenomena. As I used an article in *Psychology Today* as a springboard for an earlier part of my talk, my springboard here will be a product review in *InfoWorld* of a new version of LOGO for the Macintosh known as ExperLOGO.

This product review (*InfoWorld* of May 13, 1985) is perfectly technocentric, and I assume that its author would take this as praise rather than negative criticism. This is what product reviews are. They consist of lists of features and faults of a technical object. Their strength is efficiency in passing information when they are written and read within a culture. For example, professional programmers looking at LOGO are likely to be interested in such questions as:

- Is it fast? (since LOGO is notoriously slow compared with their languages)
- Does it compile? (since the idea of a LOGO compiler has been around for a while as an obvious technical challenge)
- How does it move data? (since LOGO is seen as a language for "toy" programs that may use interesting ideas but do not do useful work).

The review asks questions like these and gives ExperLOGO a decent rating (one *excellent*, one *fair*, and the rest *good* on its standard report card). But a very different kind of discussion is needed if the purpose is not giving grades but placing the object in a cultural context. This is especially important since ExperLOGO is the first serious LOGO (5) to be produced by a team which, in my view, has a different set of cultural values from those represented by Standard LOGO. The job of serious criticism is to recognize such cultural discrepancies and explore their consequences.

ExperLOGO is, according to the blurb on its packaging,

"a powerful adaptation of the LOGO computer language ... loaded with innovative features. In addition to standard Turtle graphics, ExperLOGO introduces Bunny graphics where bunnies frolic on the surfaces of spheres and race through 3-D space. Incidentally, we call them bunnies because they move incredibly fast, at speeds up to 100 times that of the turtle in other LOGOs."

I have a certain family feeling for people who are trying to design an implementation of LOGO since I have been involved in designing many. But for readers who have not lived through anything like it, I preface my discussion of ExperLOGO by talking a little about the experience of designing so complex a system as a programming language. The experience is itself complex; both exhilarating and painful. What is exhilarating is inventing the features of a cognitive space where people will work, live for a while, and move around. What is painful is choosing among them; there is only so much that can be included; most "bright ideas" have to go. The ever present question is: "What will we give up?"

Among the decision rules I personally use for this job, two principles have come to be most important: "effects" are in the service of syntonicity, and syntonicity is in the service of intellectual depth. To show you how this works, I will use an especially familiar example in LOGO: the turtle and the power of the turtle circle.

Everybody who has worked with LOGO knows the joy a child can get from the surprising discovery that turtles can draw circles. For me, the mathematician watching the child, there is another joy: anticipation of the development of something that the child cannot yet know. From a beginning such as repeat 1000 [fd 1 rt 1], the child will be moving on a significant mathematical track -- passing through repeat 360 [fd 1 rt 1] -- to a procedure whose input is the radius of the circle it will draw. At the mathematical heart of this procedure is the use of a variable in the instruction

repeat 360 [fd :stepsize rt 1]

and the safe feeling (which we shall see in a moment is undermined by ExperLOGO) that you don't have to think about what :stepsize will be. Whatever it is, the turtle will draw a circle.

What is important here is that the "holding power of the turtle" -- in my view based on the user's ability to identify with it physically (everyone, whether child or adult, learns to draw the circle by "playing turtle") -- fits so smoothly into the development of powerful mathematical ideas. This is *my* aesthetic. This, for me, is what makes something beautiful. This, for me, is what has cultural importance. The designers of ExperLOGO have another aesthetic. Contrasting the two provides a lesson in computer criticism.

What is beautiful for the designers of ExperLOGO is the speed of their bunny. I, too, would like speed -- and an ideal implementation of LOGO would allow you to choose between, let's call it a hare, that would outstrip even the bunny and, let us say, a tortoise that moves slowly enough for you to think about what it is doing as you watch it. But in the real world there is no such thing as an "ideal" implementation of a computer language. At the core of the process of design is the art of trade-off. If you want more speed, you have to take less of something else.

Observing what a design team finds worth giving up is a window into its aesthetics and its intellectual values.

The bunny gains speed at the cost of a kind of intellectual power that may be of no consequence to a professional programmer working on expert systems, but could be highly consequential in shaping a child's computer culture. Since this choice is made consistently in ExperLOGO, I could give many examples, but shall select one: the way Bunny commands deal with their inputs.

In standard LOGO, repeat 100 [fd 0.1] has the same effect as fd 10. For me, this is very important. When a child is manipulating LOGO, it is important that this child also be able to gain a personal sense of manipulating fractions and to follow intuitions of natural expectations -- for example, seeing that what is "on the computer" follows the rules of multiplication that apply in the world outside the computer. In ExperLOGO, bunny speed was bought (in part) at the cost of making fd treat its input as an integer. So, 0.1 is simply treated as 0. repeat 100 [fd 0.1] is the same as fd 0. Thus the relationship between LOGO and mathematical intuition is impaired, and the passage into mathematics through the turtle circle is impeded. In ExperLOGO, the instruction

repeat 360 [fd :stepsize rt 1]

will sometimes draw a circle. But if :stepsize happens to be less than one, it will draw nothing.

What kind of decision did the ExperLOGO team make in choosing speed over mathematical transparency? The point is not whether the choice is right or wrong but what it tells us about the decider. There is no obligation to be interested in fostering early development of mathematical values or nurturing a "mathematical aesthetic" in novice computer users. The designers of ExperLOGO have the right to give higher priority to speed. But this is a choice. And each choice is a reflection of cultural affiliation.

For the computer critic, what is at stake goes beyond whether children use ExperLOGO to develop programs for turtle circles -- or even whether their LOGO experience undermines their sense of mathematical values. Also at stake is the discourse about computing the way teachers, parents, and children think and talk about it, the way that talking about computers is integrated into talking about other topics such as mathematics. The crux of my own ideas about computers and learning is that their deepest role is cultural rather than instrumental. What is important about the turtle circle is not that the child drew a circle, or how fast the bunny frolicked, but that this way of working into the drawing of circles provides new ways to think about circles, and through them, new ways to think about mathematics more generally.

At the risk of belaboring what will be obvious to those who have grasped the point, I end this section by describing two imaginary classrooms. In teacher X's room the culture that has grown up around LOGO is more than usually focused on the "spectaculars." X happens not to have thought much about LOGO's mathematical values, and has not encouraged the children to adopt ways of thinking that might be offended by violating those values. Thus X is creating a different culture around LOGO than teacher Y, who has worked at encouraging the children to feel continuity between repeat and multiplication and to feel safe with variables by understanding stepsize as "just a name."

LOGO: The "Cabbage Patch Kid" of Computation?

I began by announcing that my intellectual source for this lecture was literary criticism. This source might not have been visible throughout, but its influence was there. For the individual and historically, literary criticism begins with one person and one poem: with one person's taste for a particular piece of writing. Its development is a process of *decentering*: it rises above the individual reader and above the individual work. In its maturity, it never leaves the intimate experience of reading the poem, but becomes part of a much larger experience: the individual's taste is never purely individual but a reflection of culture, and the poem is not an isolated entity but a moment in a literary movement. In a parallel way, I have sought to decenter the perception of the LOGO experience. We are not looking at the effect of a technological object on an individual child, we are looking at the workings of a cultural process.

In the previous sections, I talked about microcultures on the level of a school or classroom. I would like to conclude by talking about some aspects of LOGO in the larger macroculture, and as a first example, I will discuss a relatively superficial cultural process.

Over the past few years, there has been a change in the media's perspective on computers in education. Until sometime in 1984, most writing about computers and children had an upbeat, almost "gee-whiz" tone. One could scarcely open a magazine without being reminded that journalists had discovered that one of the most photogenic scenes of our age was a child in front of a computer screen. The light from the screen catches in the eyes and you get a really marvelous effect, just a beautiful picture.

I have suggested elsewhere that backlash was inherent in this situation: there had to arrive a point when no one could stomach the picture one more time nor the euphoric hype that often went with it. But since the media must find something to say, the next thing that was newsworthy was that computers are bad. Thus followed a spate of such negative articles. This shift has little to do with anything new that has been discovered about children and computers. We are looking at a pendulum swing. Indeed, we may predict a new phase of euphoria a few years down the line.

One might find it annoying that events of this order affect our "serious" work. But they are part of the reality in education. I don't simply mean that the mood of the press influences how easy it is to get a budget approved. More importantly, it is part of the social perception of the computer. It doesn't merely influence the educational process, it is an essential part of it.

In *Mindstorms*, I discussed how the New Math differs on a social dimension from what we are trying to do today with LOGO. In my view, one important root of difficulties in mathematics education is the social construction of mathematics in our culture as an alienated thing. This social construction is a dominant aspect of any non-technocentric view of mathematics education. Yet in the discussions that led to the New Math, the focus was not on concepts like alienation and culture, but on concepts like logical parity and what was fashionable in the mathematics community at the time. The result was an even more alienated form of mathematics. I don't say that this was the only reason for the minimal effects of the New Math movement it had other flaws as well -- but this one would have been sufficient.

We are in a very different place today. Using the computer as a carrier of mathematical learning means that we can channel the social attitudes surrounding computation to energize the way that mathematics and other subjects are learned. Again, I do not say that such social phenomena are the whole story. The relationship between the individual and the computer in the microculture of the classroom (or other learning environment) is obviously central, but the larger social movement is a very significant force. LOGO practitioners must learn to integrate it into their thinking.

The first step is to pay attention to the individual manifestations of cultural movement around computers: the pendulum swing of the media attitude, the rise and fall of debates about video games, the place of computers in movies and television, and the often more pretentious and occasionally more significant discussion in books and professional journals. For example, the summer 1984 issue of the *Teachers College Record* (published by Columbia University) was devoted to a "critical look" at computers in education. The message: computers are bad for children; LOGO in particular is a serious threat to their mental health.

A second step is to use the interest they might arouse. One can look at the *T.C.R.* in many ways. One can dismiss it as drivel. One can become angry. One can take it seriously and launch a King Canute-like campaign against computers. Or, and this is what I think we ought to do, one can treat it as a cultural event to be understood, and perhaps even made the occasion for discussion in a school, a P.T.A., or a community. The centerpiece of such a discussion could be the view of the computer as a cultural element. Many of the features of the computer that the *T.C.R.* authors found objectionable are not features of the computer but of the ways in which computers are constructed, used, and represented.

For example, Douglas Sloan (then editor of the *T.C.R.*), in a public debate with me at the 1985 American Orthopsychiatric meeting, was angry about the difference between color on a computer screen and the watercolors used by children in "real painting." He felt that working with the computer screen had far worse effects than undermining artistic development: it fundamentally changed the child's relationship with reality. We all know that the colors on school computers are less than ideal, but why is his reaction so intense? My interpretation of his position is that the difference between watercolors that run and shade into one another and computer colors as Professor Sloan understood them captures the feature of the computer that figures most prominently in a common anti-technological construction. The computer is digital, binary, all-or-none; the real world is an ultimately ambiguous continuum. I would share his anger if I felt that the minds of children were being molded into inflexible patterns. Indeed, I have expressed similar outrage at what I see as the two major influences in this direction in our society: school and the misuse of the computer. Nothing is more digital than school math, nor more guilty of sensory impoverishment.

The easy reply to Professor Sloan is to say that we have made LOGO quite explicitly to provide a glimpse of how learning need not be "digital." We are entitled to claim some credit for warning that school as it is exposes children to the very risks which Professor Sloan fears in the context of computer learning. But this reply slips too easily into technocentrism. The challenge to school, in its traditional forms, cannot be made by simply dumping computers and computer languages, however well designed, into classrooms. The schools will assimilate the computer to their traditional culture, and Professor Sloan will be proved right. A more effective answer to Professor Sloan would consist of extending computer criticism beyond technocentrism: it would

call into question social structures and cultures that existed before the computer. By describing the beginnings of a new computer culture, it would give us glimpses of possible alternatives. It would show, paradoxically, the "humanists" of the *Teachers College Record* as victims of techocentrism no less than the technologists themselves. It would pose sharply the problem of education as requiring a new alliance of intellectual trends in which the LOGO community would have a proud position.

Footnotes

1. For example, an article from Psychology Today, cited below, grants that even the best software can be ruined by poor teachers. This is technocentrism.
2. This incident gives a glimpse of a use of LOGO that will become more prominent as the computer culture matures. Up to now, one usually sees two kinds of work with LOGO in schools: exercises and projects. An exercise is a task set by a teacher or a textbook as a teaching strategy; a project is a longer term enterprise, ideally undertaken by a student out of personal interest. The initial work with clocks fell into the project category. But when the clock programs were adapted to measure the speeds of the model cars, the computer was being programmed by the students as a tool that served another task rather than as a project in its own right. The students had truly appropriated the computer.
3. I intentionally use the phrase Carol Gilligan invented for a similar phenomenon in the area of moral judgment (Gilligan, 1982).
4. LOGO environments differ in many relevant ways that are not mentioned in the reports of either study. I have become impressed with the fact that diagrams on the walls can influence what projects the students want to do and how they think about LOGO. Several of my colleagues and students have been probing the diversity of factors that make a difference. Aaron Falbel has pointed out that it makes a possible important difference whether the children see adults programming LOGO for themselves. Do the children think of LOGO as a "schoolish" activity for children, or a "real-world" activity for grown-ups as well? Steve Ocko and Mitchel Resnick have built microworlds in which the active object differs only in appearance: as a turtle, car, an insect, a ferris wheel, etc. This allows them to see boys and girls engaging differently with what is formally the same microworld. Sylvia Weir associates certain LOGO styles with spatially oriented children and Sherry Turkle associates LOGO styles with personality. In both cases, one must expect quite radically different relationships with LOGO depending on whether each individual's development of a particular style is (tacitly or explicitly) actively encouraged, simply permitted, or discharged. Robert Lawler has documented in dramatic abundance how personal one child's appropriation of LOGO turns out to be when you look at it in find detail.
5. I count versions of LOGO as "not serious" when they reduce the power of LOGO (to Turtle Graphics, for example), or when they are implemented on a machine that does not reach significant numbers of people, or when they are so eclectic as not to show any consistent set of values in their technical choices.

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