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Inventing the Future

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The Media Laboratory at the Massachusetts Institute of Technology is housed in a stark I.M. Pei-designed building that seems to say, "Serious things go on here.'' Its surface, composed of hundreds of large gray squares, is severe, almost uninviting. In his book The Media Lab: Inventing the Future at M.I.T., Stewart Brand likened the structure to "a modern appliance.''

Inside, however, a mural by the artist Kenneth Noland sets a more playful tone. Covering an entire wall of the building's five-story, sun-filled atrium, the mural is a simple geometric composition: horizontal bands of bright, whimsical colors--pink, red, yellow, green, orange, purple, and blue--on a gray grid.

Serious things do go on at the Media Lab, but a sense of play seems to pervade the place.

Opened with much fanfare in 1985, the Cambridge, Mass., lab is an interdisciplinary research facility whose mission is to "invent the future,'' specifically the future of communication technologies. Scientists and graduate students work behind doors that say such things as "Television of Tomorrow,'' "Spatial Imaging,'' "Movies of the Future,'' and "The Virtual Acoustic Room.'' If it sounds a bit like a playground for cyberpunks and techno-nerds, well, it is--but it's a playground that has attracted the financial backing of hundreds of big corporations, including International Business Machines, Apple, Sony, Polaroid, Schlumberger, Nintendo, General Motors, and Dow Jones.

In a section of the Media Lab called "Learning and Common Sense,'' Seymour Papert is trying to invent the future of school. A rumpled man with an unruly gray beard and a mischievous sparkle in his eyes, Papert, 65, is the director of the Media Lab's Epistemology and Learning Group. Born and raised in South Africa, trained in mathematics, Papert studied for five years in Switzerland with the renowned philosopher and psychologist Jean Piaget before taking a job, in 1964, at M.I.T., where he quickly made a name for himself in the burgeoning field of artificial intelligence.

Papert is best known as the creator of Logo, the first computer-programming language designed as a learning tool for children. But he is also something of an education guru--and a vocal critic of the institution of School (with a capital S). His provocative ideas on education

and technology can be found in his two books, Mindstorms: Children, Computers, and Powerful Ideas and The Children's Machine: Rethinking School in the Age of the Computer (both published by Basic Books).

Sitting in a low, stuffed chair in his third-floor office, Papert speaks in a voice not much louder than a whisper, but he doesn't mince words. "I think School is bad,'' he says. "And it's as bad for teachers as it is for kids.''

'Yearners' vs. Establishment

Papert poses this question: Why is it that "megachange'' has occurred in such fields as telecommunications, medicine, entertainment, and transportation, yet the modern elementary school classroom has evolved very little since the early part of the century? "The education establishment,'' Papert says, "including most of its research community, remains largely committed to the educational philosophy of the late 19th and early 20th centuries, and so far none of those who challenge these hallowed traditions has been able to loosen the hold of the educational establishment on how children are taught.''

Yet many people--teachers, parents, and students--are fed up with the system. And these "Yearners,'' as Papert calls them, increasingly are showing their disenchantment with School.

"Many individual Yearners,'' he writes, "simply find ways to get around School, particularly when they find School's problems directly constraining their aspirations for their own children.'' Some parents, for example, choose to teach their children at home, while others seek out alternative schools. And many teachers "manage to create within the walls of their own classrooms oases of learning profoundly at odds with the education philosophy publicly espoused by their administrators.''

School, however, remains firmly in place. "It's deeply rooted,'' Papert says, "but in order to get away from it, we have to get out of this idea that's been so thoroughly internalized, that this is the 'natural way' for learning. 'Schoolers' are people who accept that.''

Papert argues that there's nothing natural about School at all: "Quite the contrary: The institution of School, with its daily lesson plans, fixed curriculum, standardized tests, and other such paraphernalia, tends constantly to reduce learning to a series of technical acts and the teacher to the role of a technician.''

'Subversive' Computers

To make things worse, School's response to anything truly revolutionary is to appropriate it rather than accept it on its own terms. Which is why Papert believes that most attempts at school reform are doomed from the start.

Take computers. Why have they failed to revolutionize schools in the way that they have revolutionized other parts of our lives? Isn't that what educators envisioned in the 1970's?

What happened, Papert says, is that School took the computer and "turned it into a support for the status quo rather than an instrument for change. It's very striking that, in 1980, when

there were very few personal computers around, whenever one saw one, 90 percent of the time it was in the hands of a visionary teacher who was really trying to use this thing, to do something with it. But in the 80's, the school administrators got into the act, shoving them off into computer labs.''

"In the end, I think computers are inherently subversive,'' he says, "even though they are captured by the system and tamed. But the potential is still there for them to be used in other ways.''

Papert the critic gives way to Papert the utopian: "In my vision, the child programs the computer and, in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with some of the deepest ideas from science, from mathematics, and from the art of intellectual model-building.''

Self-Directed Learning

The computer as a subversive instrument--that's what Papert had in mind when he created Logo in the 1960's. Inspired by Piaget's notion that children build their own intellectual structures--for example, children learn many things, such as how to talk, without actually being "taught''--Papert set out to create a computer program that could be used by children for self-directed learning.

Computers, Papert says in The Children's Machine, "should serve children as instruments to work with and to think with, as the means to carry out projects, the source of concepts to think new ideas. The last thing in the world I wanted or needed was a drill-and-practice program telling me to do this sum next or spell that word! Why should we impose such a thing on children?''

What Papert and his colleagues at M.I.T.'s Artificial Intelligence Group (the forerunner to the Media Lab) came up with has been modified many times since 1967, when it first appeared, but the basic elements of Logo remain unchanged. By typing simple commands on a keyboard, children can direct a screen "turtle'' to move in any direction; the turtle's path becomes a line, thus allowing the user to create an infinite variety of geometric shapes. For example, a square can be drawn by using the following commands:

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FORWARD 100
RIGHT 90
FORWARD 100
RIGHT 90
FORWARD 100
RIGHT 90
FORWARD 100
RIGHT 90
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Children who use Logo learn the language of geometry not by memorizing facts and figures but by creating their own images. Papert calls this "Turtle Geometry.''

"Since learning to control the Turtle is like learning to speak a language, it mobilizes the child's expertise and pleasure in speaking,'' Papert explains. "Since it is like being in command, it mobilizes the child's expertise and pleasure in commanding. ... Working with the Turtle mobilizes the child's expertise and pleasure in motion. It draws on the child's well-established knowledge of 'body geometry' as a starting point for the development of bridges into formal geometry.''

Serious Work

In the world of Logo, the teacher becomes more of a guide, a "debugger,'' than a dispenser of knowledge. "The Logo teacher,'' Papert writes, "will answer questions, provide help if asked, and sometimes sit down next to a student and say: 'Let me show you something.' What is shown is not dictated by a set syllabus.''

Logo students "start interacting mathematically because the product of their mathematical work belongs to them and belongs to real life,'' he explains. "Part of the fun is sharing, posting graphics on the walls, modifying and experimenting with each other's work, and bringing the 'new' products back to the original inventors.''

Children in a Logo classroom, Papert says, have the sense that they are doing something consequential. "Unlike in the arithmetic class,'' he asserts, "where they know that the sums they are doing are just exercises, here they can take their work seriously. If they have just produced a circle by commanding the Turtle to take a long series of short forward steps and small right turns, they are prepared to argue with a teacher that a circle is really a polygon. No one who has overheard such a discussion in 5th-grade Logo classes walks away without being impressed by the idea that the truth or falsity of theory is secondary to what it contributes to learning.''

Michael Tempel, the president of the nonprofit Logo Foundation, estimates that some form of Logo is available in about half the schools in the United States. The latest version, called Micro-Worlds, has received positive reviews in the electronic-learning press. Yet many schools continue to use the computer merely as an extension of the traditional "transmission model'' of teaching, effectively turning powerful machines into nothing more than expensive flash cards.

Empowered by Video Games

To Papert, it's no surprise that computer-aided instruction, or C.A.I., has failed to impress students.

He offers this anecdote: "I was observing a child working with a C.A.I. program for multiplication. There was something strange going on. I had seen the child do several multiplications quickly and accurately. Then I saw him give a series of wrong answers to easier problems. It took me a while to realize that the child had become bored with the program and was having a better time playing a game of his own invention. The game required some thinking. It redefined the 'correct' answer to the computer's questions as the answer that would generate the most computer activity when the program spewed out

explanations of the 'mistake.'''

Video games, on the other hand, offer a glimpse at the power computers have to transform the way children learn. Papert urges parents to try to understand what it is about these games that so captivates their children.

"Any adult who thinks one of these games is easy need only sit down and try to master one,'' he writes. "Most are hard, with complex information--as well as technique--to be mastered.'' Video games empower children "to test out ideas about working within prefixed rules and structures in a way few other toys are capable of doing'' and "teach children what computers are beginning to teach adults--that some forms of learning are fast-paced, immensely compelling, and rewarding.''

Papert has been criticized for taking video games seriously--and for soliciting a $3 million grant from Nintendo to develop learning tools that look and feel more like video games than schoolbooks. The three-year project ended last year, but Papert makes no apologies for it. "Change in education isn't just going to come from ivory-tower academics,'' he says. "It's going to come from all sectors; academia, yes, but also from industry, from toy makers--that's part of the culture of children.''

Logo Meets LEGO

Papert's most fruitful relationship has been with LEGO, the Danish toy company known for its colorful, interlocking plastic bricks. Since 1989, Papert has held the unlikely title of "LEGO Professor of Learning Research,'' a designation that seems to amuse him to no end. Asked about the title, Papert grins from ear to ear, jumps out of his seat, and grabs what he calls the "LEGO Chair''--a small throne made entirely of LEGO pieces and embellished with rotating LEGO turtles. A gift from the company, it represents Papert's attempt to break down the barriers between school and play.

In the mid-1980's, Papert was looking for a way to match Logo with real-world objects. "Children love constructing things,'' Papert reasoned, "so let's choose a construction set and add to it whatever is needed for them to make cybernetic models.'' LEGO--one of the few toys left that allow kids to create objects of their own design--seemed the perfect building material for such an endeavor, so Papert pitched the idea to the company. "And that turned out to be the start of a good relationship,'' Papert says.

The result was LEGO-Logo, which Papert and his colleagues fieldtested at James Hennigan Elementary School, an inner-city public school in Boston's Jamaica Plain neighborhood that has long been associated with the Media Lab. There, 3rd, 4th, and 5th graders used the Logo software and the LEGO building blocks--along with a variety of motors, sensors, and gears--to create small robotic objects: pop-up toasters, carnival rides, cars, and trucks. One student built a house with lights that turned on automatically after dark.

LEGO began marketing LEGO-Logo in 1988, and it is now used in thousands of classrooms across the country. But Papert believes the learning tool can be improved. Currently, LEGO-Logo objects are connected to computer equipment via standard electrical wires, which

limits their mobility. Papert would like to see the system become more portable.

For several years, one of his graduate students, 26-year-old Randy Sargent, has been working on a remote-control version of LEGO-Logo. In the LEGO-Logo Lab--a cramped room full of Apple computers, bins of LEGO bricks, and assorted tools--Sargent holds a gray box, about the size of a cigarette pack. Stuffed with sophisticated electronics, it will make the remote-control version of LEGO-Logo possible. (Fieldtesting of the new version will begin in the spring.)

Sargent, a self-described "nerd'' who as a child always was building things with LEGO (although never in school), seems like a kid in a candy shop as he shows off one of his creations--a six-legged LEGO "walker'' that moves back and forth in frantic motions. It looks like something out of one of the "Star Wars'' movies. "I would say my three really big interests are education, computers, and LEGO,'' Sargent says. "And here they are, all three of them. I'm completely amazed that I can spend all my time doing this.''

Project Headlight

Gilda Keefe teaches a class of bilingual (English and Spanish) 4th graders at Hennigan Elementary School. She managed to get through Mindstorms, although she admits that she "didn't understand it very well.'' And she hasn't read The Children's Machine, Papert's most recent book. Yet Papert has had a significant influence on her life as a teacher.

When Keefe began teaching at Hennigan six years ago, the school was two years into Project Headlight, an attempt to incorporate some of Papert's ideas about computers and learning into a school environment. About 250 students--one-third of the school population--in grades 2 through 5 take part in the project, which is a collaborative effort of the Media Lab, I.B.M., and the Boston public schools.

Each student in Project Headlight spends at least 45 minutes a day working on one of 125 I.B.M. personal computers, which are equipped with a Logo-based software program called LogoWriter. Most of the computers are grouped in two large circles in a common area outside the regular classrooms.

Teachers in the project have a great deal of freedom in deciding how they want to use the computers. Keefe, for instance, uses Logo for "Turtle Geometry,'' but she also uses the software for an interdisciplinary telecommunications project that links her 4th graders with students in other countries.

For a study of bird migration, Keefe presented her students with a list of birds that migrate from Massachusetts to Costa Rica. Each student then selected a bird, researched it, and shared the information with the rest of the class. Then they used the LogoWriter software to draw pictures of their birds. Using a modem, the students sent video images of their drawings to electronic pen pals in Costa Rica. Meanwhile, the Costa Rican students, who had been working on the same project, transmitted their own drawings to their North American friends.

No More 'Fake' Exercises

Keefe sees many benefits to teaching with telecommunications. For one thing, by allowing her students to carry on conversations with Spanish-speaking children in another country, such projects give her own students an important sense of validation and self-worth. And, of course, they show that distant countries are filled with living, breathing people.

"I think Dr. Papert has terrific ideas,'' Keefe says. "I like his philosophy a lot. Since I started teaching at Hennigan, I've really thought a lot about how I teach. My role has changed. I've become a learner along with my students. We're both part of the learning process. I'm not like a traditional teacher--the one with all the knowledge.''

Papert's ideas about the benefits of video games are the basis for another project at Hennigan, called "Children as Designers.'' In the project, which is led by Yasmin Kafai, a postdoctoral fellow at the Media Lab, 5th-grade students spend four to six months creating video games that teach about fractions. Using the LogoWriter software, the students design their games in whatever manner they choose. Many, of course, base their games on ones they are familiar with, such as Nintendo, but some make up their own. One girl, for example, based her game on several Greek myths.

As part of her dissertation, Kafai compared the 5th graders with students who learned about fractions in a more traditional manner.

"We found that there was a significant improvement for the children participating in these design activities,'' she says, "not only in the learning of mathematics--even though we did not have any particular 'instruction'--but also in terms of programming. So our main argument is that if you want to talk about computers in school, you have to move away from these fake little exercises, and you have to find projects where kids really become programmers and designers.''

"You can capitalize on the interest children have in video games,'' Kafai says, "and turn it into something productive, into a rich learning experience.''

Diverse Users--and Uses

Project Headlight isn't the only place where Seymour Papert is making a mark. Although few schools use Logo to the degree that Hennigan Elementary does, many have incorporated the software into their regular curricula, and Logo seems to have developed a loyal following in the United States and abroad.

Logo users' groups meet regularly, and Logo conferences have been held in such far-flung places as Greece, Australia, Costa Rica, and Venezuela. Since last spring, the Logo Foundation has published a newsletter, Logo Update, that features a front-page column written by Papert. (In the first issue, he wrote: "I am sometimes introduced as 'the father of Logo.' The aspect of parenthood of which I am really proud is not conceiving the idea in the first place but staying with Logo and participating supportively in its development--as a father should.'')

Because of Logo's open-ended nature, how it's actually used in schools is hard to track. Both

Papert and Michael Tempel of the Logo Foundation admit that some teachers and districts use Logo in ways that run counter to its intended spirit. Tempel says he once visited a classroom in which a teacher was trying to use Logo to teach her students a rigid geometry curriculum. She wanted her students to create specific geometric shapes on their computer screens. But because Logo doesn't say "Wrong Answer'' if a student types in a "wrong'' command, some students ended up producing different, unexpected objects.

"Logo,'' Tempel points out, "is always creating something, and that something often turns out to be more interesting than the 'right' answer.''

MicroWorlds

Ironically, the latest version of Logo, MicroWorlds, contains some nonprogramming elements, which Logo purists have objected to. Designed (with Papert's help) and marketed by Logo Computers Systems Inc. of Canada, MicroWorlds Math Links, MicroWorlds Language Art, and MicroWorlds Project Builder allow students in grades 4 through 8 to use text, color graphics, sound, and animation to create their own projects.

Kids using MicroWorlds Language Art, for example, can write poems, greeting cards, and advertisements and then enhance their creations with sound and graphics. Electronic Learning magazine called MicroWorlds Language Art a "wondrous toolbox. ... The spectacular effects created with MicroWorlds are not meant to simply add glitz to a project. Students are encouraged to use these tools to communicate meaning, to deepen their understanding of language, and to discover creative ways to express their ideas.''

Ihor Charischak, the president of the Council for Logo in Mathematics Education, sees MicroWorlds as Logo's attempt to compete with some of the more popular multimedia software programs, such as Apple's HyperCard. (See Education Week, March 29, 1989.) "Programming is very important,'' he says, "but some of the newer applications are more connected with the real world.''

Papert estimates that only 1,000 schools use Logo in a way that is "significant for the learning experience of the children,'' a fact that used to bother him. Now he seems more philosophical about it. "What's happening is the understandable process,'' he says. Misuses of Logo, he says, can be seen as windows on how School operates.

The whole-language approach to reading instruction, which has much in common with the Logo philosophy, has suffered a similar fate, Papert suggests. "There's been a critique of School for a long time,'' he says. "I think Logo expresses that critique in a new form. I think whole language is a very good idea that captures an aspect of that same critique. I think in both cases they are a revival of a subversive idea. And the response of School has been to neutralize them. But most of what I see being done under the banner of whole language is better than doing nothing.''

A Call for 'Little Schools'

In Mindstorms, Papert the utopian writes: "I believe that the computer presence will enable

us to so modify the learning environment outside the classrooms that much if not all the knowledge schools presently try to teach with such pain and expense and such limited success will be learned without organized instruction. This obviously implies that schools as we know them today will have no place in the future.''

Then, he adds: "But it is an open question whether [schools] will adapt by transforming themselves into something new or wither away and be replaced.''

Now, 13 years after Mindstorms appeared, Papert seems ambivalent about the fate of School--and about his role in whatever transformation may occur. On the one hand, he is sympathetic toward those who choose to give up on the institution altogether, such as home schoolers. "I see [home schooling] as a positive thing,'' he says. "It's a reflection of the growing perception that School isn't O.K., that it isn't necessary.'' Yet Papert is also committed to changing the system from within, as he and his colleagues are trying to do at Hennigan Elementary School.

In the concluding chapter of The Children's Machine, titled "What Can Be Done?,'' Papert urges parents and teachers who share his vision of the future to go even further: Abandon the system and form their own "little schools.''

"A central feature of the little-school idea,'' he writes, "is that it permits a group of like-minded people--teachers, parents, and children--to act together on the basis of authentic personal beliefs. Instead of imposing a common way of thinking on everyone, it allows people with a shared way of thinking to come together.''

"My point is simply that a very new opportunity exists for mobilizing a larger public in pursuit of educational change,'' he argues. "And it seems to me very clear that a dynamic little school that is itself based on a principled stand on the connecting issues is in a much better position to do this than a cumbersome traditional school.''

In other words, a megachange in education will surely come--but why sit around waiting for it to arrive if it can be hastened along? Why should teachers who seek radical change beat their heads against the wall of School if they can create alternatives?

"If you don't try to make things better,'' Papert says, "you can be sure they will turn out worse.''

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