A conversation with Seymour Papert, Marvin Minsky, and Alan Kay

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The challenges of IDC: what have we learned from our past?

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When we consider the history of technology and children, the noteworthy leaders that come to mind include **Seymour Papert, Marvin Minsky, and Alan Kay** who, over the years, have challenged us to bring together the lessons of educational reform, artificial intelligence, computer science, and human-computer interaction. What follows are excerpts from a conversation between this pioneering trio and David Kestenbaum, science reporter from National Public Radio, during the opening keynote panel at IDC 2004.

David Kestenbaum: You talked about computers and information. Why do we need computers at all? What's wrong with crayons and dirt?

Seymour Papert: If we recognize only the informational aspect of the computer the answer is simple. Once upon a time information was handled orally, writing extended what could be done orally and printing went further. The computer is another step in the same series. But there is much more. The deep contribution of the computer to education comes from its being a constructional material as well as an informational medium. Children can use it to make far more complex and intellectually rich constructions. It allows a shift in balance from learning mostly by being told to learning far more by making and doing.

Alan Kay: The importance of the computer is how you learn mathematics and it allows you to think about mathematics, and how it allows children to think about powerful ideas in mathematics. Children are capable of learning plenty more mathematics than anyone gives them credit for with or without a computer. We've seen many examples of this over the years.

Marvin Minsky: The worst thing about computers is that the keyboard is not a real keyboard ... There's the idea of mathematics and music. The fact is that almost all mathematicians are pretty good at music, and almost all musicians are not very good at mathematics. Don't know why. One theory is that they have something better than mathematics, the other is that they are using the part of the brain that would have been used for mathematics. When children learn to play music they are not taught to learn about what's happening ... Look at the opportunity we are missing of teaching children about all this.

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Kestenbaum: Sometimes kids are not interested in all subjects. You can trick them with games, but...

Minsky: The idea of general education, I think, is terrible. If you find a child who is interested in something you should encourage that. Help them build a tower of ideas. Instead of that, we send them to a class of social studies or whatever and never give them a chance to fanatically spend time doing something, criticizing something, pushing them further. The school day is designed to keep you from thinking deeply about a problem.

Kay: One of the brilliant ideas of the San Francisco Exploratorium was that they wanted to teach kids just one thing: that the world is not as it seems, which is a point for the epistemology of science. But the ploy was to make 500 exhibits where 2000 kids trying different things would eventually match up with the exhibit that spoke to their interests. So, I think it's important for children to start with something that interests them so you can build a tower of ideas. At some point, the child has to be doing stuff when they are not supervised, for their own reasons, 24/7, which children can really do when they are interested in something and eventually they all start contacting the other powerful ideas in the world. There aren't that many powerful ideas, and it's important to go after them from one's own motivation. I believe that every child should learn to read and write, every child should learn math and modern science. But the important thing is that it has to be the child's possession.

Question from the audience (age 9): My name is Zoe, school in some ways is bad, but in some ways is good. Like in reading it's really fun, and in math it's really hard and boring.

Papert: One reason for the difference is that you read stories that feed your imagination. Math really is boring for most people because it is not connected with their interests and their fantasies. You can't make it part of your dreams. But listen carefully: I didn't say that *mathematics* is boring. It is a fraud to say that "math" (which is the stuff they teach in school) and "mathematics" (which has been called the Queen of the Sciences) are the same thing. Teachers try to make math interesting but it is really boring for them, too, because most of them don't have any personal interests that connect with what they teach in school math. So they pretend it's just there to teach you to be logical. The big difference computers can make is that they allow pieces of mathematics that children and teachers can learn to be connected with topics that interest different people—music, graphics, movie-making, robotics, and science.

Question from the audience: People are better able to do tasks when those tasks are connected with everyday reality. If you express problems in terms of everyday experiences, people understand them better. I wonder whether the panelists have any comments on framing their ideas in people's everyday realities.

Papert: Yes and no. You learn things better when they are connected with things you are passionate about. Connecting math to things that you don't care about doesn't help even if they belong to everyday life. For example, nobody is duped when school textbooks try to make seven times six "relevant" by making it seven eggs at six cents each. What counts to you is your mental world of interests, dreams, and fantasies, which are often very far removed from everyday life. The key educational task is to make connections between powerful ideas and passionate interests: for example, when someone who loves games uses mathematics to program breathtaking action.

Minsky: The most important thing in learning is copying how other people think. I don't think learning by doing really gets one to emulate how other people think. The way to learn something hard is by getting new ideas. How do you do something in your head? ... We need a cultural situation where every child has an adult friend who they can emulate. And communicate their ways of thinking to the child. Do something that gets each child to spend a few hours a month with someone worth copying. What we do now is to take a six year old and send him in a room full of six year olds. The result is that every person grows up with the cognitive capability of a five year old.

Kay: I completely agree. I go to a music camp in the summer. What you see there are people with different abilities playing in the presence of master players. The camp doesn't accept coaches that won't play in the concert. Imagine a fifth-grade teacher assigning a composition and actually writing one herself. Shocking! What teachers do is broadcast in every way possible that "I'm not interested in this at all because I don't do it." I think it's unthinkable to teach six year olds to be six year olds. You need to have these models. It's like grad school. You go there to find professors that are more like you'd like to be and try to understand the way they think.

Kestenbaum: Are there countries in the world that are doing better? Is anybody doing better at getting these big ideas into schools?

Papert: In many countries I have visited, or learned about, little schools with only one or two teachers. It's the best model we have, where the teachers, the parents, and the students are tightly connected in the community. We can do better with smaller settings. And with the technology the disadvantages of being small go away: even the smallest school has access to the worldwide library and can do real scientific investigations. We should learn from them and change our concept of school.

Question from the audience: The Internet isn't what everyone expected. What do you see in the future of developing technologies for children?

Kay: I'd like to see things much less cluttered so that we could work on them better. ... The best way to use current technologies is to try to put your results out for free as open source. Education is an area where when someone does something good for children and puts it out for free on the Internet it is great. Climbing one more stair to get up the tower of this cathedral. If kids can get it for free it can have a tremendous influence. ... The Internet gives people the opportunity of putting things out, and people are doing it. I realized that the way to do something about this is to put out alternative content. The trick is getting to the place where people can see alternatives, and that's the best thing people can do.

Kestenbaum: Lessons from the past. Something that didn't quite pan out. Something interesting. What do you think the answer to that is now?

Kay: Most of the stuff we did was a failure. We got a little better at it when we tried to at least have good failures. Where you have some idea of why, rather than just negative results. That took a while.

Papert: Let's not be so impatient. It's only been 20 years since computer technology has been widely available. What bigger changes happened in the world in less than 20 years? I think our learning revolution is happening much faster than we have any right to hope it would. Look at how long it took from the time cinema technology started to when Hollywood made movies widely available! We are doing wonderfully.

My basic idea is that programming is the most powerful medium of developing the sophisticated and rigorous thinking needed for mathematics, for grammar, for physics, for statistics, and all the "hard" subjects. In short, I believe more than ever that programming should be a key part of the intellectual development of people growing up.
—Seymour Papert

Kestenbaum: How long before we have HAL?

Minsky: If you look at my Web page there is an article titled *Steps for AI* from 1961 that describes what should be done. If we had actually followed that pretty closely we would have been done by 1980 or so. That paper had a plan, which would have worked out quite well. But along the way something went quite wrong. Many missed opportunities. What happened is that during the 1970s there was a lot of work on getting machines to understand language, understand a subject, and suddenly there was a change toward particular applications. ... People are trying to find the magic bullet. The brain has four hundred computers, all doing different things. The idea of finding a central theory is inappropriate. What you want to do is make things as complicated as you can rather than making them as simple as possible. Around 1980 there seemed to be a switch. On my Web page you'll also see a link to my book, *The Emotion Machine*, which has my latest theories on what to do now. It's interesting how people gave up a dream of making a machine that would understand things.

Kestenbaum: Let's talk a bit about Logo (the noted computer language Papert invented in the 1960s to teach children about programming). Is there a role for kids to program? Do you still see that as a good idea?

Papert: Definitely. Even better than it was. But remember that the idea of programming itself is something in evolution so it won't mean exactly what we thought it meant. This is too complicated to explain here, but my basic idea is that programming is the most powerful medium of developing the sophisticated and rigorous thinking needed for mathematics, for grammar, for physics, for statistics, and all the "hard" subjects. Maybe I would even include philosophy and historical analysis. In short, I believe more than ever that programming should be a key part of the intellectual development of people growing up.

Question from the audience: A lot of the discussion has been around schools. What's the role of after-school programs and other public spaces?

Kay: After-school centers can move from possibly generating some exciting experiences, to enough comprehensive coverage. If it happens in a museum kids generally won't be able to get follow-up. The key is to do the follow-up.

Question from the audience: There are limitations in current education systems. What is the role of the computer?

Papert: For me the fundamental question is how deeply school is shaped by the properties of pen and paper and writing. My own view is that truly significant change will not come until paper-based technology cedes its primacy to electronic-based digital technology—and even then it will need time for knowledge to reform itself to fit the new medium of expression. If this is true then small changes within a paper-based school do not add up to much and this is why school reforms have had such a history of failure. *Perhaps* I am wrong. But I throw out this challenge: look at the mega-changes that have come to medicine, communications, entertainment, transportation. Perhaps there is some fundamental factor that makes education the exception. But if so let's see some serious effort made to discover this fundamental factor.