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Terrence Cannings: Seymour, can you tell us about your overall impression about the current middle school math curriculum?

Dr. Seymour Papert: Can I digest that? The math curriculum in the middle school is probably the worst part of the math curriculum. I think that it's neither real mathematics, doesn't introduce any new powerful ideas, it's rehashing what the kids have already done in elementary school without getting into any depth. I think it's pretty bad.

Do you want something more specific than that, ha? Let's be more specific.

The middle school math curriculum's got to be thought of in terms of the entire math curriculum. It's part of that. Basically, the math curriculum that we are dishing out to students is determined by a previous age of media where we only had pencil and paper and so almost everything in it is determined by what you can do well with pencil and paper, and that's totally out of touch with anything that's real in the modern world today. There's a deep kind of discordance between the spirit of school mathematics and modern life and students are very sensitive to this and realize that it doesn't have any real substance or relevance, intellectual or practical.

Now specifically about the middle school math curriculum, I think that it makes a semblance of introducing some deeper ideas, like you're beginning to get into a bit of algebra, but it doesn't really get into what algebra is about. So it's ritualistic. It's a ritualistic version of algebra.

I like to say there's a big distinction between something that I love and called mathematics, and something called math, which is what we teach in schools and that's not a mathematics curriculum it's a math curriculum.

Speaker 1: Can you describe that distinction a little bit more about what you see is the difference between school math and your concept of mathematics?

Dr. Seymour Papert: Mathematics is an active, intellectual activity, and it means working at things where you're using the mathematical ideas that you're struggling with for a larger purpose. The idea that the larger purpose could be discovering something that the teachers decided you've got to discover is not a larger purpose; that's just play acting and the kids are quite sensitive, quite aware of that. I think that at that age, kids could be doing quite complex projects using computer technology, or we're doing a lot of stuff with non-computer technology using mechanical things, with Lego for example, and building devices with gearing and involving, trying to maximize the force or how steep

a slope a vehicle can climb up. There's room in that for a lot of mathematical thinking, which typically what you learn in middle school doesn't, it's not really what you need. Even if it does teach you .... Nominally, the kind of mathematical idea to ... could use, you don't learn how to use it.

Take multiplication, for example. Kids think of multiplication as something you do to numbers. You're supposed to learn these multiplication tables, and you do some rituals called multi-digit multiplication. For me as a mathematician, you're not dealing with multiplication at all. You're only manipulating the formalism. Understanding multiplication is like understanding what is the kind of relationship between, say, time and distance and velocity. Why is it a multiplicative rather than an additive relationship? There's nothing in the way the we talk about multiplication in elementary school or, for that matter, in the kind of work that pre-service teachers get, that even prepares them to even see that as a meaningful questioning. It's multiplication because that's the formula, but that's not an answer. Multiplication has to do with a particular kind of relationship where there's a certain kind of linearity and a certain kind of particular relationship of proportionality.

I think they just don't deal with the ideas. School generally is a little bit idea averse. In mathematics, it's almost entirely idea averse since you learn skills; you learn how to do things. Even when you learn how to solve certain puzzle-like problems, you're never dealing with the ideas.

Speaker 1: Let's take that a little step further. You've just been appointed the Director of Curriculum in Malibu, California, choose whatever you want. Early, you talked about these powerful ideas that should be part of the middle school math curriculum. Wave your magic wand, and if you had your way, what powerful ideas would you see that should be introduced in the middle school math curriculum?

Dr. Seymour Papert: The most powerful idea of all is the idea of powerful idea. The most powerful idea about mathematical ideas is seeing their power. Take an example that you really you dug into a lot and try to deal with a different agent. The idea of probabilistic thinking is one of the most powerful ideas of all time as measured by the impact that it had on the development of science or thinking in general, even outside of what you call science.

Now look at the way probability is dealt with in any school curriculum. You never dream for a moment that this had any power. What's the probability that girls like chocolate ice cream better than vanilla ice cream? Go and count all the girls and count how many like chocolate ice cream and how many like vanilla ice cream. Divide the one from the other. Now you can take a guess of whether a girl will like chocolate ... well this is ridiculous, go and ask her. It's not helping you solve a real problem or get an insight into anything.

Now contrast with that ... building it into a technological context.

One of the things we like to do is construct a little robotic kind of vehicles using computerized Lego in the Mindstorms spirit. Suppose you made one of these things that will go towards a light, and that's an interesting programming in itself that has another interesting mathematical idea, but I'll come back to that.

For the moment I now think of the situation. Suppose that they are obstacles in the way, and it'll block against an obstacle. You've programmed it so that it's got a light sensor, and the program consists of a question, is the light more to the left or more to the right? Turn appropriate, and take a little step forward and repeat that.

That's a program, easy to write, but if there's an obstacle, the thing will just block against the obstacle and not be able to get there. How can we change the program to deal with the fact there might be an obstacle?

Now one way is to build into this little mechanism, touch sensors and ways that it can detect that it's not advancing, that it is blocked, and then do something about it, and that's pretty complicated. Interesting, but complicated.

There's an altogether different way. If you just throw some randomness into it, and you say, "Well, generally what it does is what I said, but every now and then, it just randomly turns." If there aren't too many obstacles, it's still going to get there because it will get away from the obstacle.

Now I think of that as a powerful use of probabilistic behavior. It's powerful where you got a result. It's powerful where we're going to look at the way that nature has solved the same problem in simple organisms whose nervous systems are too simple to have the kind of programming that would enable it to analyze the obstacle and see its way around.

You see the bees in the flowers doing exactly that. It's powerful where it connects you with phenomena that you see in nature, and you can get to understand them. It's powerful where historically it connects in with the history of physics and so here's an approach to probability that is see in terms of its power, its intellectual power, and its usability power and that's a contrast with just divide the favorable cases by the total number of cases and get a number. So what?

So I think that illustrates what it's like to deal with probability as a powerful idea, but it also does something much more important. You mightn't care

about probability, and you still might, through that kind of experience, come to appreciate what it is for a mathematical concept to have power and be seen as powerful.

Speaker 1: Let me take that to a specific example, put you in a different role. Let's say you're working with a bunch of pre-service teachers who have an undergraduate degree or whatever, and you're saying to them to approach the way we think students should learn, what kind of environment would you advise them to set up in a classroom and in the middle school? Again, these are pre-service teachers about ready to embark on a career. What advice would you?

Dr. Seymour Papert: First of all, no advice is of any use in this day if they had the same kind of experience themselves. That is if their experience is sitting in a classroom being talked at and doing pencil and paper exercises, they just won't get it. They might get it from outside that is despite your attempt to make them think that everything is about what you can do with pencil and paper in a classroom. They might be interested in watching the bees and the birds and they might be into sailing or who knows what they might be interested outside, so they might import from their lives.

If you want to create the kind of environment where you can foster that sense of powerful idea, you have to create for them kinds of experiences where they can spend a lot of time using these ideas. Moreover, I think when they're working with kids and they practice teaching, if you're going to send them into classrooms where the kids and the teachers were supposed to be their role models are doing things in this disempowered way, you undo anything that you might tell them. I know what I'd say, advise, drop out of school and go and work with some kids somewhere and really learn what it's like to solve problems and learn things.

Speaker 1: Which is probably very smart thing for them to do otherwise they become images of what they've seen before. Let's just take them on for example. The teacher training institution, your recommendation is get them out of traditional mode, get them out of traditional school, and give them experiences where they can work with kids and see how they learn.

Dr. Seymour Papert: I think it's incomprehensible to me that we still continue trying to prepare teachers for the future by immersing them in the Stone Age experience of what it was like to learn in the past. I suppose saying it's incomprehensible is a slight exaggeration because what it really means is the enormous power of institutional cultures, cast in institutional concrete with vested interest of all sorts of people, and these certificates that have been established and these textbooks that have been printed and, there’s a whole massive set of factors that make for the perpetuation of the way the teachers are prepared, but it

has no meaning except a negative one in relation to preparing them for teaching in the future.

Speaker 1: From your past experiences, what if you can, can be the most optimal strategies for helping future teachers understand how students work? Where do you put them? What experiences do you give them so they'd first understand the way kids think?

Dr. Seymour Papert: I think if you, when you think about how you can help teachers think about how kids learn, you can't do that except in a situation where they are learning. I, for a long time, tried to develop a kind of course, which I (taught) at MIT for a lot of years and a lot of the students from Harvard Graduate School of Education always come.

What we do in this course, we take ... we're talking about learning, talking about styles of learning. How do you learn? You can't learn about learning without learning something. At the same time as you're talking about learning, we take some problem area that's difficult for them.

One example that I've found most successful, it is borrowed from Eleanor Duckworth although she doesn't use it quite the same way, in that we take the moon, the appearance of the moon. The phases of the moon everybody understands a little bit, but there are so many questions you can ask about the moon like, when it's a crescent moon, does it rise like that and set like that? Or does it go like that or like that, for example? How does that rising at the time it rises from day to day vary? And so on, there are millions of questions; these aren't astronomy questions and astronomers. It's pure naked eye, what you see looking at the appearance of the moon.

I have these students, these are over the course of a semester, and so they've got plenty of time to make lots of observations of the moon. They observe the moon, and we try to discuss how we can understand what its appearance… and some of the questions are really hard that you can get into, but by the end of semester, they are going to be able to handle these questions very easily. They're going to know how to think about them. They will have learned what it's like to develop a set of representational and living skills to handle a set of phenomena.

I don't care whether they ever going to use this or if they are, it's going to give them a richer relationship with the world around them as the moon is in all our lives, but the important thing here is that as we do this, as we're learning to think about the moon, we're also talking about the learning process and how we went about in different ways.

I found this very successful in developing a greater kind of articulate consciousness about learning and thinking. This goes deeper than anything that you can say in giving lectures or doing little problems and they get a deep experience of surprise. They're surprised when they see other people finding very easy what they found difficult or finding very difficult what they found easy.

So moon's one example. Another example is probability, to mention that again, that you can diddle puzzles about probability and statistic sets, something very hard for most people to understand. In fact there's a whole literature by psychologists about how bad people are at thinking about probability.

We'll take probability. We'll look at funny situations, where people get themselves tied up in knots and can't understand it. Over the course of a few months, we'll talk about why is this difficult? Let's talk it about intuitions, how can we sort them out, what's the process of getting your mind a little bit clearer about that, and this always in relation to constantly discussing how to go about learning.

I think that's one side.

Speaker 1: Holding that thought there. This morning you talked about the Maine experience where every kid's getting a laptop. Where do you see in that process, of inserting the technology into learning about how kids learn, so we can connect the two?

Dr. Seymour Papert: I chose an example talking about the moon which doesn't really involve using computers, although if you got a computer, you can use this to make a representation of what you're thinking about the moon or make a little model, use it to get into the web and get statistical data or get into NASA, get pictures. Having the laptop would enrich this whole process, but I think more than that, more important even is the fact that with your computer, you can embark on project of a more constructionist kind with the computer.

For example, trying to develop a game of your own on the computer lands you in a lot of mathematical situations where you really might want to use probability to make a surprise element. Or ideas of representation of shape and space and coordinates. Having the computer as a medium for construction, for building things, puts you in a position of being able to embark on projects where you would encounter powerful ideas and, in a way that you use them to serve a personal purpose.

Speaker 1: Holding that again and coming up to the level of the middle school math teacher, who's been teaching for 20 years and we're trying to help them assess where they are with kids learning and the pedagogy and the content, what three pieces of advice would you give to a so-called experienced teacher to get them thinking in this way?

Dr. Seymour Papert: I go back to this. It's no good getting them thinking unless they are also doing something different. I would give them the advice of immersing himself in some real activity that involves a lot of mathematical thinking and might involve mathematics he doesn't recognize as mathematics because for him very possibly mathematics means that little, minute sliver of mathematics that has been selected out for what we present in schools. But I'd advise him to get into something like any of these activities that I was mentioning before.

I think it's probably necessary for him to be open to recognizing that middle school mathematics; most of it is not mathematics, because unless you recognized that that is not mathematics, you're not ever going to recognize what is mathematics.

Then paradoxically, you then cannot bring out what is good mathematics in what they're doing in middle school because you don't recognize… am I saying that right? I think… Of what they do in middle school, there's no doubt there's some mathematical content there. The idea of an algebraic representation is a powerful idea, but school algebra is not a powerful idea. The idea of algebraic representation is lost in a morass of skills and rules and solving problems that don't involve much thinking, but only involve finding the right answer.

Unless you recognize all that is not mathematics, you're not able to strip away that chafe and find the real kernel there of the mathematical ideas that's still all there and that are important valuable ideas.

That's very hard for that math teacher because he's been professionalized. He's got a big stake in believing that what he's been doing for 20 years is very good math. It's the students' faults that they haven't been able to understand it, or maybe it's the fault of some technique that he doesn't have, but accepting that right down at the core, there's something wrong with the whole thing. That is hard, but that's what he's got to face and that's what he's got to do.

Speaker 1: What do you say to parents, Seymour? You say that the accountability movement we're seeing right now is what they think should be happening because this is the way it was in their day and this is holding teachers now accountable to what they see is truly school math. What do you say to these

parents to say that what we're measuring is a very minute part of the learning process? How do you get them to think about these powerful ideas too when they've been brought up through the system?

Dr. Seymour Papert: First of all, I'm going to clear the ground by assuring them that if the kids do real math, they're still going to be able to do well in those tests. This I'm sure of. There's no question about it that the best way to get the high score in the test is not to be teaching to the test and try to teach those particular things; that if you just back off from that and forget about the test for a while and get the underlying ideas really straight, you'll find you can learn the test stuff very fast and do better. There's just lots of experiences where that happens.

We see a lot of these with the homeschoolers. It seems to be pretty generally established that with an hour a day of doing schoolish stuff, they do better than the average school kids who are spending five hours a day on it.

I'd build up some confidence in that way that we're not going to put your kid in a position where we say don't pass that test because ... whatever we think about the test that if kids have got to, if the kid does not pass the test there are going to be consequences in the world. They're not going to be able to get into college, get jobs, etcetera. I'd reassure the parents first of all. Then having done that, I think I'd try to get the parents into the kind of situation where they can appreciate and go through the more active learning process that the kids do.

Sometimes you can't do that. Something that I find often is very powerful is that when the parent sees the kid becoming enthusiastic, when the kid comes home and really is bubbling over about all the stuff he did today at school, and he gets up early in the morning because he doesn't want to be late, most parents can realize that something really interesting is happening, and most parents will not say that's bad stuff. They can see that the kid is learning and is growing.

Speaker 1: It's a tough process though.

Dr. Seymour Papert: It's slow process.

Speaker 1: We might want to stop here. We're getting to the end of this tape. Before we get into the middle of another question, I'd like to stop and put a new tape in there.

Speaker 3: I might need to get some water.

Speaker 1: We have about 26 minutes that we've recorded so far.

Tape Change----------26.25

Dr. Seymour Papert: I think that's an important issue there.

Speaker 1: That's one.

Speaker 3: You started to expand on that, but the parent thing, how do we...?

Dr. Seymour Papert: So, if you did talk about the pencil and paper stuff, the methodologies they've got are maybe about as good as they can get and to try to have another methodology using the same knowledge technology, that doesn't work very well. I think it's very a different story when you can get these kids really immersed with using technology like computers and robotic constructions and things of this sort, sufficiently for the kids to be really involved with it. That means much more time and much more support than they get in 99% of the schools.

Now under those conditions, you can have a very deep, powerfully new way of dealing with mathematics that's rigorous and deep, more so than the standard school method; but without that technology or using the technology in superficial ways, it's really very hard to find constructive ... to find situations where the powerful ideas can be learned in a constructionist way because they don't have anything to build with, where the mathematical ideas are really powerfully relevant.

I think it's clear that in my view, the conflict that many mathematicians see between the desire for more experiential, activity-based, project-based way of doing the mathematics, which most mathematicians would like but then they see a conflict between that and the rigor and the depth that the most scholastic approach has used, and that's given up in almost all attempts to make the mathematics more experiential.

We need to have new mathematical ideas, and we need to have a new kind of context for using them, and if under those circumstance we can put the two things together, but then you got to have the technology and you got to be prepared to take a different route to mathematical knowledge than month-by-month or semester-by-semester following the laid down curriculum pattern.

Speaker 1: If you don't use the word constructivist, what do you use?

Dr. Seymour Papert: I use the word constructionism.

Speaker 1: You don't use the word constructivism….

Dr. Seymour Papert: Deliberately I use the word constructionism because I want to say constructivism has gotten a bad name and it's being diluted, and let's have another word that's got the same spirit of what that was trying to do.

Speaker 1: There's a whole movement now in California right now that even constructionism, if you want to use that term, is really a bad way to go because, again, it comes back to paper and pencil you talked about earlier because that's what gets measured.

Dr. Seymour Papert: You can't fight that on paper; you can't fight that abstractly. We've got to fight it by creating model situations where you can see a lot of kids learning in a different way.

Speaker 1: How do you do that?

Dr. Seymour Papert: You do it, that's how you do it. I don't think you can do it in a mass scale. Any attempt to sell the new idea or any new idea on a mass scale to a state is bound to be disastrous because it's going to be diluted and down to nothing.

You, Pepperdine, you could be creating a lab school. How do you persuade parents? You don't. You get the parents who would be happy doing it. You get the teachers who, in advance, are inclined who want to do that sort of thing. You show you can get good results.

Then the question of whether these are generalizable, that's another question, but you shifted the ground from that - these constructivist methods are bad to - here are very good constructivist methods and how can we get them generally adopted. That's a different level of discourse, and it's not that it becomes easy, but it becomes meaningful. You can really go about that and you're dealing with substance, with the real issues.

Speaker 1: One of the things we can do in this Math Star project is that we could begin to build these lighthouse projects that you just described this morning and just alluded to now.

Dr. Seymour Papert: Yes. I think that to talk about changing the way mathematics is learned without doing some nucleus projects that make radical far-reaching change is I think quite hopeless because you're going to make small, incremental changes to a system that's highly equilibrated.

I like to use this analogy. Imagine the system with a lot of things tied together with elastic bands. If you move one piece and they'd go to a snap back, but if you move the whole thing around into a totally different state, it might stay there until we go into something else.

Female: Stop for one minute.

Speaker 1: What advice can you give us as to a project, knowing what we're trying to achieve.

Female: Or to our teachers.

Speaker 1: Pardon me?

Female: Or to our teachers in the project. What advice can you give all the players, right?

Female: You know that we're working with specific schools, middle schools, group of teachers. What can we do to help them?

Dr. Seymour Papert: I don't think you can do anything to help them unless you are doing something that is very consequentially done and that you're really doing it in a thorough, qualitatively different way. I think if you can create such models, people who are not in a position to go all the way with you because of constraints of their school boards and so on. If they can see where you're going, they're able to make the best of the kind of limited opportunities they have; but if they can't see where it's going, they don't know what they should... they're like a boat at sea without a compass, they don't know, you tell them to do this and that, and they don't know why and they can't really deeply appreciate what it's all about, and so they don't do it very well, and they resist it. They don't fight hard against the constraints that are placed on them, which they would do if they could see, I want to get over there and here are these obstacles. I want to battle against those obstacle.

Speaker 1: Comes back to what you're saying this morning. Is that like a vision thing?

Dr. Seymour Papert: Yes.

Speaker 1: To help move this ship in this different direction, that we've got to get them involved not only in doing it, but we're able to see where it's headed.

Dr. Seymour Papert: I think the fundamental question is like a vision. If we can give those teachers a vision of what it could be like, then that they deeply appreciate and feel that, they will push in that direction. Eventually, they'll get there.

Speaker 1: What have you found to be the most effective ways of getting them to see the bigger picture of where it's going? In your own words

Dr. Seymour Papert: The most effective ways, if you can put them in a situation where they experience that kind of learning. The next best is to have it close enough so they can see it and talk to other people that are involved in it and get to feel a little envy, and then "I wish we could be doing that." Then you've got them position where they might actually try and where you can help them do it.

Speaker 1: So the teacher that says, "I've always taught algebra. I've taught algebra this way." You got to get them into this exposure of seeing a way it can be done differently without penalizing where they are at the present time.

Dr. Seymour Papert: I think then the strategies for making it easier to accept. I wouldn't come along and say he has a new way to teach algebra. I would say, Here's a situation where we can do work that isn't about algebra, but to which algebra is relevant.

Now we maybe have to recast the algebra so it can be used and so it can be picked up and its relevance appreciated by the students. They're much more open to that because you're using what they know and you're not putting them down, but then maybe in a while, they begin to see that that's a better way to think, another way to think about the algebra.

Once you can plant in their minds that there's an easier way to do it, they will follow it. They also want to get good results there. They don't want to be failing to teach the kids algebra. It's just they ... it's hard for them to bring themselves to see that there's something fundamentally different they could be doing.

Speaker 1: What do you say the principals who often are the gatekeepers of a lot of these stuff? What do you say to them that will also get them to have the same reaction? You get them involved as well?

Dr. Seymour Papert: Yes. In Costa Rica, where I was involved in a project of bringing computers, and with it, project-oriented work for the first time into schools. The schools who will be given these computer labs, there was a lot of competition. Every school wants to be in the first round of getting them. It was possible to say, "If you want to get it, you got to do 1, 2, 3, 4," and one of those things was that the teachers had to have a three-week immersion course before they started, and the principal had to participate in the first week.

The principals were motivated enough to want to do it because they wanted to get the prestige. There's absolutely no doubt that those schools where those principals came did much better all around than schools with the principals who didn't come. Most principals could appreciate it, plus they'd

been in a little bit of the actual immersional workshops for the teachers. They got a taste of it.

I participated in a couple of those and saw principals who came along, very reluctantly because they thought they were coming along as a, being prepared to pay this price and do the silly thing in order to have the computers in their school. By the end of the week, were often converted and really is enthusiastic as anybody, as I was.

Speaker 1: Everything you said, we're sitting here embarking on this major project with MathStar, one other piece of advice would you give us as a team.

Dr. Seymour Papert: Don't try to make random teachers follow a new methodology. Find the teachers and the schools and the parents or the schools who are already inclined to go in that direction and empower them to do it.

Speaker 1: Can you stop one sec?

Dr. Seymour Papert: You've dug yourself into a hole that you can't get out of.

Female /Speaker 1: [Crosstalk 00:38:30]

Dr. Seymour Papert: That's probably the ideal situation anyway because then you've done something this year and next year in the schools. I would publicize as widely as possible what's going on, what you've done, and see which schools say, "We would like to be in that." Or which teachers or which principal.

Now I'd might also pay to not have the whole school involved. I don't know whether they do or not, but if you ... within that school building, if all the teachers are expected to go along with this, you got to ...

Speaker 1: Just the middle school math

Dr. Seymour Papert: Or even all the middle school...

Female: Even the middle school teachers, just the ones that really want to.

Dr. Seymour Papert: If you can let them sort out so that those who want to be involved can do it. I would try very hard to find those who are more open to not separating mathematics, to merging math with science, with other subjects, and break away from the subject discipline separation. It's very disempowering because it reduces mathematics to something that you can't really use because using mathematics at that level usually means applying it in some other area.

Once you become really highly mathematized in your head, you can use the mathematical idea to construct mathematical edifices, purely abstractly, but you've got to have gotten into mathematical thinking pretty deeply before you can do that.

These kids at the level that we saw historically, mathematics started not as a separate abstract thing that was applied to real world problems. It started just a particular way of doing things like building pyramids or planning your irrigation or doing trading or navigation or whatever that we're doing. Then gradually mathematical ways of thinking in those areas developed, and then gradually became separated out.

We tend to reverse that order in school. It start with the separated out thing, and then try to rationalize it afterwards by applying it, but that's topsy turvy.

So to the extent that if you can find schools where you can find a group of teachers in a school and a principal prepared to put together a multiple discipline, especially science, math, technology. Maybe writing, too, English and music and art and whatever they're prepared to put together. The more they're prepared to put into this pocket, the better chance you've got for mathematics being a powerful thing used to do other things.

Speaker 1: Anything else you want to add to that, ask to that? Seymour, let me just jump in here, one of the political realities we have is that we did not have much choice in, as Jean said, in the selection of these first schools. In looking at this from a changed perspective, would your advice be that we kind of do something with these schools then we only concentrate on the second round where we got more choice?

Dr. Seymour Papert: Yes, but I don't know how bad this situation is, but I could easily imagine that that's the right thing to do.

Speaker 1: To do…

Dr. Seymour Papert: I think that if you can find one school where you can really get the ideal combination of teachers, parents, principal, kids who are really prepared to go along with it. Politically, you can make much more out of that. Scientifically also, what you can learn from it.

Speaker 1: That really applies to the conversation we're about to have about Pepperdine's role and MathStar here, Pepperdine's role getting affiliated with this network that you're all putting together, so it's the same concept.

Dr. Seymour Papert: Absolutely, it's the concept I'm trying to...

Female: Just like you said this morning, where there's numbers that are important to people, all of a sudden with the number of teachers that we had involved that was important, it wasn't the quality, it was also, "Well you only have seven?" I would've just liked to of started with two or three and instead the whole department, they really appreciate…

Dr. Seymour Papert: Who is this 'they' that you're talking to there?

Female: I'm not sure if it's our…

Dr. Seymour Papert: Funding agencies?

Female: I don't think so. I think it's the way the grant must have been written.

Dr. Seymour Papert: The way the grant was written, but…

Female: They're for….

Dr. Seymour Papert: … the people who wrote the grant might have thought the people that they're writing the grant for…

Speaker 1: …wanted that…

Dr. Seymour Papert: … wanted that, but they might not have been...

Female: It works for now.

Dr. Seymour Papert: They might have been wrong.

Female: We're modifying an awful lot of things. I think we're…

Dr. Seymour Papert: I noticed there are these "Preparing Teachers of Tomorrow" programs.

Female: Teacher training…

Dr. Seymour Papert: Now they have a bunch of those that most of those I've seen are written for a large number of teachers on the assumption that that's what the only way to get it, but there are some exceptions. For example, Iowa state is an exception. I know there's a work in there. They wrote a grant for that with I said we're going to do it in a very small scale, very small scale, like with 20 students, and they got it.

Now I don't mean that the other problems I think about the way they're doing that, but they didn't need to do it on this, on the large scale.

Speaker 1: That's often the perception of the writer, who thinks it's what they want to hear from the funding agency. I think one of the messages for us today is that where in the current schools of being selected, where they've got the whole departments, you might want to get back and re-think and say who are the teachers here who really want to be part of this? Forget the departmental approach, and just go with this two or three, teachers, while we look at new schools, where they're more as you described.

Dr. Seymour Papert: That's what I think.

Speaker 1: Any other piece of advice you can give us so it's good luck.

Female: Move to another state.

Female: Move to another state.

Dr. Seymour Papert: I think an important piece of advice, maybe it's part of what I've been saying, but I think that, if we're dealing with pre-service teachers that you really have to work at the level of doing different sorts of things in classrooms as well as different sorts of things in the teacher's experience. If you do either of those without the other, you just can't get anywhere.

They very seldom put those together. They're almost always, you're either doing something about pre-service teacher education or you're doing something about classroom.

Speaker 1: It's experienced teacher; it's always "them or they". It's never "us".

Dr. Seymour Papert: Yes, it's...

Speaker 1: Which is something we can talk about again later. Any other questions, Jean?

Jean: This is very refreshing because we have a lot of college mathematicians who are not real happy with integrating mathematics or some of the newer units. We have some counterparts in California that are very vocal…

Dr. Seymour Papert: I think the point about the mathematics ... This is something else maybe we can talk about that. I'd like to maybe get involved with you on a dialogue with this mathematician, and California seems to be a hot bed of mathematical community getting engaged in essentially a reactionary way against "for back-to-basics" teaching.

My experience in talking to a couple of them, I haven't talked very much, but talking to a couple of people in the mathematics community and looking at

the stuff that gets published and on the various websites. It's obvious to me that most of them do not have any example in mind of how you could have an alternative way of doing mathematics that is still rigorous.

Their impression is you giving up the essence of mathematical thinking. The only way that they know how to get back to that at the level of this K through 12 or certainly K through 8 kids, means going back to basics, or they're going back to traditional mathematics, plus they don't have another model.

I don't have another model either that's compelling and believable except in a technological context, but the people pushing for more experiential mathematics are not pushing it in this technological context.

Speaker 1: So one of the….

Dr. Seymour Papert: These critics are actually right. If you don't discuss the abstract principle concretely, what does the constructivist kind of mathematics mean? In reality, in the schools, it's pretty bad. Its well intentioned, beautifully motivated. It's the direction everybody who cares about kids and about good learning would like to go, but the people who are doing it don't know how to do it. They don't have the means to do it, and they are not doing it in any credible way.

Speaker 1: One of the things we can come out of this, with the MathStar project is to show the technology in this environment to show that there is an alternative model.

Dr. Seymour Papert: Yes, but then we really have to get to the mathematical substance of ... It's not just how to teach.

Speaker 1: I think it's extremely important for us to hear that. Can you verbalize a little bit more for the tape that if you were ... had the ability again to be emperor of this project...

Dr. Seymour Papert: If I had the ability to be emperor of this project, I think the first intellectual trap I would try to fight against is the educators' way of thinking that my job as an educator is to know how to teach something that somebody else has specified for me, rather than to think about what is it that could be taught, that would carry the deeper kind of opportunities to learn.

I think that there's some very different sort of mathematical areas that would be very good for kids at different ages, which are not part of the curriculum, but if the kids could go through them and make connection with real mathematical thinking, you could then go very quickly into dealing with the stuff that is in the curriculum.

An example, which unfortunately is never ... very, very seldom been used in that way, but this whole area of turtle geometry that was very much at the core of early Logo and still is very valuable material, but it's usually used as a way of kids doing graphics or learning about programming or learning about the computer, or when its used for them learning any mathematical concepts, very much on the surface. They learn about angles or about polyhedra. It's very seldom used as a way to get young kids into a feel of what its like to do mathematics, to feel the power of mathematical ideas.

That is an example of where some mathematical ideas lie, like the idea of a theorem. One of the important things about calculus is thinking of process in terms of little pieces, thinking of it locally. What we try to do with the turtle, you think of a making a circle, by move forward a little, turn a little, and so on. Or programming this Lego construct to go to the light by making small steps and iteratively, constantly, correcting.

Dealing with a basic idea about calculus, which is never in school calculus courses because it's just too abstract to present what they'd like to present in school calculus or pre-calculus courses as they, the manipulation of symbols, which is far away from these fundamental ideas.

I'd work at trying to find powerful ideas that I can give to these kids, selected not for whether they are directly part of the curriculum or not, whether you can dress them up to be part of the curriculum, but whether they lead into ways of thinking on which we can later build what we want to have in the curriculum.

Speaker 1: You're not getting confronted by the state test?

Dr. Seymour Papert: They will do better on the state test.

Speaker 1: Say that again.

Dr. Seymour Papert: They will do better on the state test.

Speaker 1: [much hearty laughter from all speakers]

Dr. Seymour Papert: Do you know the Cyber School I was mentioning? They do the standardized test there; their kids do well on it. I know there are all sorts of questions you could raise because it's hard to find a control group that matches those kids exactly, but on the other hand, they clearly show that it's possible to have a completely open learning experience and still do well on the test.

Speaker 1: It worth going to visit that school?

Speaker 1: I said, is it worth going to visit that school?

Dr. Seymour Papert: It might be worth visiting the school.

Speaker 1: Cyber School, which is a school that sounds….

Dr. Seymour Papert: It's in Seattle. Cyber School is this thing I've been mentioning, it's this homeschooling school. I don't know how many school departments do this but I've seen his creeping in a little bit in the part of the world where I live in Maine. We went through the process that first off, there are a lot of people pulling their kids out of school, homeschooling. Then there were kids who wanted to be in the school band, use the school library, in one case that I know, but I believe there are many more like it, a principal got this smart idea. We'll let you enroll in the school. We won't insist on your coming, we won't pay attention to how often you're coming or not coming.

Then you count in our statistics so we get funding on the basis of your being there. You can get to use your school facility; so everybody gets ... everybody's winning, except the sticklers for the regulations. After a while, this was happening so much that they made it legal, and now it's legal in the state for schools to allow homeschoolers to mix and match and pick out and do part of the school activity and not all of it. They've got some formula for how this enters into the funding process.

I think this is happening all over the place, that there's this movement towards more relaxed, that kids can get out of it. The homeschooling statistics, again, it's not been really rigorously done, that's something that should be, but such as it is, it seems pretty compelling to me that the kids in homeschooling on the whole do better academically than the kids in schools.

Speaker 1: Would that mean that it has something to do with the supporting kind of environment?

Dr. Seymour Papert: Of course. It's got to do with all sorts of things. That's how we talked about… tit's got supported environments, but it shows that it's possible to do well in the test without going through the teachings of the test. We just hold on to that point. There are other ways of getting to results in the test than keeping your nose at that grindstone. That's a point we need to get established.

When that's established, you won half the battle, because then you can talk about how to create the conditions that will get the kids there, but you've broken out of this feeling that parents have that they're terrified that if you're not being drilled for the test, they're going to lose out necessarily.