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Text will be edited soon

Dr. Seymour Papert: I'd like to take a different tack. [Ulrich 00:00:06] has talked about some good things that happened through working [inaudible 00:00:10] I've been associated with and it's wonderful and it makes me extremely happy. I'd like to talk today more about the role we have … the problems and what has not been done. I thought I'd start by talking about language and so put that little quotation up there which I want to use in two different ways. One is content and one is language. Now, as for the content, we'll come to that, it's most of what I want to talk about.

As for the language it's become fashionable to laugh at Latin and to laugh at the idea that people should learn Latin. Let's remember that not so long ago, for example when I went to school, some very intelligent, caring, sensible educators were quite convinced that any child who did not learn Latin was a child left behind. (laughing) We tend to laugh about it. I'd like to explore some ways in which perhaps we're laughing too soon.

Now, laughing too soon not because I want to go back to learning Latin but laughing too soon because there's a reasoning, that reasoning for … those excuses as justifications given for Latin are probably much better than the justifications that are being given today for teaching other things. I want to try to distill out a view of some of those justifications and not in order to necessarily support Latin but to maybe we can invent a new Latin. We can identify something that could more effectively play the role that those educators want to preserve through Latin.

Now, also for the content of that, I'm going to assume that everybody knows about it enough to recognize that it's Latin. That some of you went through all that time spent and can actually read it. It's interesting I think that almost everybody who speaks English can look at that and spend a little bit of time and puzzle out what it means. Just good enough kind of … it obviously has to do with in mathematical service and some sort of asking questions of being compared with answering them. That's all I really need for this, for what I want to say today.

Male: (laughing)

Dr. Seymour Papert: Because what I would like to do is emulate although hopefully modestly here, not trying to … This is our demigod for somebody like me. David

Hilbert who at a Congress of Mathematicians early in the century may have had the biggest contribution to shaping 20th century mathematics by posing 12 problems, 12 problems unsolved. It wasn't that he thought that knowing these answers to these problems was going to be so momentously important. What we thought his deep intuition was that thinking about those problems, working on those problems would give rise to great intellectual richness and he was right.

Among other things, these computers came out of it. Not that he anticipated or invented anything like a computer but he recognized ideas that were going to mature, whose seeds are going to grow into the ideas of the whole [inaudible 00:04:13] and basically produce this machine. That image of not inventing it but planting the seeds doesn't grow and finding how to nurture them is one of the things that I would like to bring out in the course of the next, a little less than an hour. It's the asking of the questions and not the giving of answers.

I'm afraid that what I'm going to do is going to be a little bit dense so I would like to refer to some places where you might find some more details if you are patient. One of them, it doesn't need much patience is my website which is created by [inaudible 00:05:09]. Those are the titles of two books in which I'm working simultaneously and I thought I'd mention the titles, their provisional titles because they also illustrate a theme of what I want to say. One called Fiddling while Rome Burns: Computer and the Future of Children. I believe that this is very accurate.

Rome is our education system, maybe it's learning, maybe it's the children, maybe it's the whole world. I think that we are in the midst of a learning revolution and I think that the education establishment is fiddling, is watching us and continuing to play these little games and I mean fiddling in two senses. One reminiscent of Nero and the other fiddling with the details in the system that is radically obsolete. It's going to collapse. I dare say in the many thousands of people getting papers together, I saw them, which I'm not going to …

Male: (laughing)

Dr. Seymour Papert: Because I don't want to be unkind. I think that most of what has been done in education research is going to be obsolete before it can get into practice. I'd like to give some indications of where … some other direction, where else could we go? The other book I'm working on, so that's a sort of manifesto book. The other book is meant to be serious and it's about where are the deep ideas we could grow on and slightly pay for the … The provisional title is Piaget, Minksy, Chomsky and me, three [inaudible 00:06:54] thinkers, how we translate the ideas into a vision of learning.

I'd like particularly to emphasize Piaget has [inaudible 00:07:04], I worked with for a long time. I think Piaget has been given a rough deal because of the widespread idea that somehow he has been disproved or demolished by new discoveries. I must say something about those new discoveries but not much. I think the important point is that it was being … they had a raw deal long before and they had the wrong deal, with, he was translated by the psychology community into something that he wasn't.

That something is certainly refutable, probably refuted but there's a different side of Piaget that has been much less influential in psychology circles, American psychology circles in particular. I think that is very much alive in its force and the important aspects of it should be reasserted rather than put aside into historical courses, the past history of our subject. Chomsky is the one of those that I haven't actually worked with very much but he is a constant presence of I think another point of view that is often seen to be opposed …

He sees himself as opposed to the position of Piaget. I'm going to suggest ways in which because that apparent opposition between these two comes about because of a very limited narrow view on education and learning that was imposed on us by the very primitive knowledge technologies that we have before the coming about of digital technologies and computers. I think that we are now in a position to say that they were both right and we can resolve those conflicts in order to do some [inaudible 00:09:13] how to do that.

We'll [inaudible 00:09:22] that for a while and so that's a lot to want to say in a short time. Since I'm going to content myself to know by only really asking the questions, I'm going to make a lot of assertions but I'd like you to take them in the spirit that what I say, I believe of course but my real intent, what I think is more important about what I say is not whether it's true or false, or its specific quality but question that lies behind it. Behind the question, behind an assertion is the question that I want you to ask those questions. I want to encourage others to ask those questions.

Now, I'm going to look at a big span of how we could think about a different world alone. I'm going to have to look at this one through different points of view. From the point of view of the individual learner and of the knowledge and the point of view of the school because good or bad, schools are there as an institution. Unless we take account of their dynamics and how they work and how they don't work, we are not going to be able to really effect change and are going to get a little critical of the way in which people are thinking about the dynamics of school.

Sort of as sociologists and people thinking about the dynamics of learning and individuals as psychologists are very often so destroyed form one another that each is bound to fail in their purposes and are going to really then say, an idea about why it is true that why education reform has proven to be impossible. I will keep that language and then … I would look at the individual, the school and the society, these three different themes. I will discuss them separately and then try and they'll probably come together.

Before even discussing anything in detail, I'd like to indulge in my habit of using parables and metaphors. I'd like to tell my story briefly in the form of three parables and one of them is an old one, it's used often but it's grown and one of them is a new one. It's about a country in which for reasons lost in history, people's diet consisted almost entirely of [Foreign language 00:12:23].

Now, this has then led to a lot of health problems. It was very difficult for people to survive but somehow they manage, thanks to very brilliant doctors, medical specialists who really had figured out how to cure the diseases that came from over indulgence of [Foreign language 00:12:47] and add little bits here and there to make it work. One day, somebody said, those conditions that made it impossible for us to get a great variety of foods has run away. We can now get all sorts of things because now we have all sorts of technology. Why don't we make a new diet? It is a very radical suggestion. All sorts of objections were raised by [Foreign language 00:13:16] was good enough for my grandfather, it's good enough for me.

Participants: (laughing)

Dr. Seymour Papert: The real reason, the real deep reason why it was very hard to just keep going is that these very brilliant medical researchers and doctors, what they were expert about was [Foreign language 00:13:36] and how to deal with that. They would know nothing about how to make another diet, how to do something else. I guess I don't have to spit out the translation into relevant terms. I think we're feeding our children [Foreign language

00:13:57] intellectual [Foreign language 00:13:59] and we don't really know how to make another diet. This is our problem. How do we go about making another diet?

This can't be a simple thing to do. It's too big a thing to get your PhD on, to get tenure on, to write a paper on, to get accepted by the conference. It's just everything is stacked against the modern intellectual [Foreign language 00:14:27] doctors can't read what is really the real problem. This was what I'd like to [inaudible 00:14:36] into how to go about who's making some inroads into identifying what are the things you have to do to make this [inaudible 00:14:46]. The second parable is one that I've used politically and Ulrich mentioned how I persuaded the governor of Maine to embark on a program that's been picked up, creating waves all over the world [inaudible 00:15:03] of giving every kid a computer.

I think what really got him was this little parable called a country which I'll call Hu-bong, which were a huge, a very high level of civilization has developed, great poets, great philosophers, great mathematicians, great sci- … all sorts of people but nobody had ever thought of writing. Of taking an instrument and they didn't write, they didn't draw, they sculpted it and didn't paint … One day somebody invented writing, and very quickly, the business people grabbed on to it. It was so they could communicate into distance and the scientists and this became known as RCT. The idea eventually dawned on somebody, why don't we put RCT in schools?

Male: Yes.

Dr. Seymour Papert: Then they start … They were cautious people so the debate was how do we do this, how do we start? Should we put a pencil in every classroom? Or should we, in each school, have a room where there's a mountain of pencils so … (laughing) They tried all sorts of things and there's no doubt, it all led ingenious teachers and enthusiastic lovely creative kids find very interesting things to do with these pencils. The important point is that what they could do with those pencils had nothing in common with the role of writing in our culture.

What we can do with computers by putting a computer in every classroom, or even six or even 10, still has nothing to do with whether it's possible for the computer to become a new medium other that could displace the pencil as the medium of expression. That hit Angus King, the governor of Maine. In the next two years, I had no idea, that was in … The next two years was mostly up to here again. Local politics and fighting with legislators, writing columns in newspapers and it was a very interesting experience.

It taught me one more lesson about if we were to change this thing called education, you can't do it by confining yourself to proving that this way of teaching biology is better than that way of teaching biology. This is a big social problem that has many dimensions and I've tried in my life, it's scattered but I've tried to work with mathematicians and philosophers with toy companies, with LEGO and Nintendo and Disney and with politicians and with these governors, now ex-governors. (laughing)

That's the simple form, the short form of that parable. I would like to mention something. The deeper form that I didn't even suggest to Angus King. I'm not even sure that I'd thought of it by that time, of extending it in this way, probably not. We laugh too quickly at these people in Hu-bong who objected. If you really think about it, there were very good reasons why they should oppose this idea of making such a huge transformation to the media, to the level, the education system …

Some objections is [inaudible 00:19:06], some that really had happened in our own tradition from quick times of people saying … but we worked very hard on kids developing memory power. Let them write and they would develop memory power. Look, we've got these wonderful curricula. I want to show you one other thing here.

Female: You need to move …

Dr. Seymour Papert: Was they had, of course they did mathematics but they didn't do mathematics only by … They didn't do it by making marks on paper. They made it in lots of other ways. First of all, the mathematics was mathematics in [inaudible 00:19:51], is people learned mathematics by doing thing that involved mathematical ideas and therefore it was a much better way of doing mathematics. Then I was going to show you on the slide, I don't know why it isn't coming up, it doesn't matter. This is Chisanbop. This is a Korean way of ... You can find it on the net. It's really fascinating actually.

A very elaborated way of doing computations, arithmetic with your fingers. If you learn to do that, you can do the kind of algorithms that we teach but they're not the same algorithms at all. They are effective. This new thing wasn't going to help these algorithms, it wasn't going to help the kids pass their tests. Same finger math, if that's what they're doing. On the contrary, it would confuse them about that and so on. You can see if you try to use some imagination, why there were many obstacles. The many obstacles really are real disadvantages but we know that writing had such a powerful overwhelming advantage in other respects that it overwhelms all these difficulties.

However, they don't know that. It was going to take time for the advantages to develop. The real difficulty then, getting the transformation to happen was that developmental process. How could it develop and we could say pencils would be better, writing would be better. What about the transition from where they were Monday to where they could be one day? That developmental process is something that is as important as the content of what's taught. We could have another example, a more real one of their developmental … that same sort of situation that I mentioned because …

I'd like another example to emphasize the need for a word, to words that are important about learning. I've used the slogan for a long time. It's why, instead of trying to make the kids love the math they hate, why not make a math they will love. Why not indeed? A simple answer, two kinds of answers, three kinds of answers. One, we might not know how to do it. It's taken a long time for me to get little toe holds on some ways of doing that. I'll be talking about that. Some people … At least [Ulrich 00:22:54] also worked very hard to make toe holds of what it would be like to have another math. It's hard work.

It's going to take time to take root and grow. It's going to have all sorts of obstacles like these are the few barriers and we will come to some other obstacles. It's not something that can happen suddenly. One of the reasons is we don't have language for talking about it, don't we? Because when I say, I'd like to do another math and you mean make another curriculum. No, but I don't mean make another curriculum. You're doing mathematics like we do it on pens and paper, it's not another curriculum for what Hu-bongians do with their finger math. It's a different thing.

Another example of a different thing that's a real one in this case, if you think, imagine that we've all used roman numerals that we haven't invented Arabic numerals. Under those conditions, you can do with Roman numerals, you can do everything you need to do, you can do calculate, you can keep your records and but it's much harder work to do it and much harder to learn. Now, it so happened that whoever invented Arabic numerals did not do it … I think did not do it as an educational enterprise. It couldn't have been, couldn't.

Let's imagine that there's this world that no one knew Roman numerals and it's an educator who gets this wonderful idea. Here's Arabic kind of numerals that we use. This is a different what? A different curriculum? No, it's not. It certainly wouldn't help us get past the standardized tests of that time which is all about Xs and Vs and Is. It serves the real purpose that the arithmetic serves. We need a name for something, creating some different thing and I know what the name is but I'm going to take off from the fact that it doesn't seem so bad to say make a new math.

Then I'll always like to make a huge emphasis, the difference between math which is what you learn in school and mathematics which is this great jewel of creation of the human mind. These are not to be confused. Math, this thing we do at school, it's a particular thing. It's a tiny little sliver of mathematical knowledge selected for why, who selected it? Nobody knows but it was selected in times longer than (laughing). That has become a sugar myth. We think all kids should know that. When I said we laugh at the people who said we should learn Latin but we laughed too soon, I think one could laugh just as much.

Imagine people in the future laughing just as much as us, what we're teaching kids at school because. Let's introduce a word for distinguishing them. I'd like to distinguish between Latin-esque justifications. We're putting something in and let's say driver-esque. Driver-esque because here's an example. If you talk about driving a car, learning to drive a car and passing a test for your license, it's very clear that there's knowledge that you need that you're actually going to use. You need that knowledge.

Even then it's not necessary when somebody could invent a car that could be driven … but basically I think that the spectrum, it's driven by what goes into the curriculum and driver educations what you need in order to drive. As opposed to Latin-esque justifications where I'm not talking about in the previous centuries where Latin was the actual language that they spoke in universities but when I was a kid, nobody was learning Latin in order to speak Latin. We learned Latin because it would do certain other things. I don't want to discuss what it does, those other things. It's the form of the question.

If we think about what we learn in mathematics at school, it's all Latin-esque. You're almost … 90% of it. Whoever uses that formula for solving a quadratic equation or who would ever factors polynomials? Whoever … You could right along and go look at it all. It's not stuff that people are learning, because they actually want to use that. It's a semantic thing there that it's interestingly hard to breakthrough that. People say, we need to know math because the modern world, you can't survive that. That's talk as if math, mathematics was some unitary thing which all or none, you have it or you don't have it.

Then yes, I'm not going to question that mathematics is a useful thing but the question is what mathematics, which mathematics? Which parts of it? When you start breaking it down by that, it becomes less obvious that math is something that you have to know for this to exist in this world. I don't know what … alternative maths, other maths? Let's call it a mathoid. A mathoid is something like the use … A familiar example, a mathoid is math in school. What I mean by mathoid itself, it's going to represent certain slice of knowledge, the way it's represented, but also a culture of how you think about it, how you talk about it.

Your attitude towards it. How it affects your attitude towards yourself and people like it's part of the math culture, I would say that we believe that some people are good in math and some people are not good. Or that there's such a thing as mathematical intelligence. This is part of a … because all of those is part of math. There's a moral aspect to the two because there's a hidden part of it that I think is terribly important.

That is that because it really is useless stuff in the real world and because teachers are not brought up to believe that the Latin-eque justification is a good justification. They don't know how to present the Latin-esque justification to kids. When kids ask them why should we learn this, the answer is always as if it was driver-esque and not that you can use it somewhere. Everybody knows you're not going to use it. The natural side of that is something extremely bad and that is kids say consciously or unconsciously, there they go again lying to us. It's teacher double talk.

It's undermining a sense of moral integrity in the education system. Nothing could be worse than that. All this pieced together, that's what math is. It's a whole cluster of stuff so we wanted to talk about what do we have to do to make another different mathoid? I am going to say … going into my third parable which is actually … The third parable is not quite a parable, but it's a parable-oid interpretation of … Leonardo da Vinci made some very ingenious sketches of flying machines. Leonardo was a practical person and he made many practical things.

He took them and realized them but he didn't make a flying machine. How come? If you look at his sketches, you can say, they wouldn't have worked but that's not why he didn't make a flying machine. He didn't make a flying machine because he didn't have the technological infrastructure to implement his own ideas about making a flying machine or else he would have found out they were not so good as everybody does the first ideas not working and he might have improved them.

The reason why he didn't do what the Wright Brothers were going to do was not that his ideas were inferior to theirs, or they were but … I don't know what the Wright Brothers' ideas were either when they first started. It's in favor to the Wright Brothers' ideas implement but he couldn't because they weren't machine tools, there weren't fuels, they weren't engines, they weren't materials. Nobody could invent all the stuff, it had to grow and develop before you could make a flying machine.

I think that many people who tried to make mathoids or educoids or other forms of education, Dewey and everyone. All the great thinkers about it but I think they were writing about it. I think that before we had this digital technology, it was not feasible, it was not infrastructured to implement a mathoid at that time ... I may say, I was going to say before, I'm using mathematics only as the extreme case but I still don't know whom that is … to do everything. We now have the same opportunity of how can we use this structure.

Now, those are the end of my parables and in a minute, I will come back to those reference points but now, getting into some more technical specifics. One thing that got from Piaget is the word, epistemology. Because Piaget had refused to call himself a psychologist. He didn't use the word psychology, he used department. He [inaudible 0:33:33] was named, Genetic Epistemology because he thought it was about [inaudible 00:33:38].

That's how I came to view this because mostly you think somebody who wanted to investigate how three, four, five-year-old children think about number, who would you find as your assistant for that, would you find a psychologist, of course. Piaget was a psychologist, he wanted a mathematician because he was convinced that not that the mathematics in the child's mind would emulate the development of mathematics in real mathematics being called by mathematicians but that the same sort of noble points, the same sort of obstacles come up for both of them.

He dared to think in the same breath about the foundations of mathematics, of the mathematical thinking of children. That idea has been thrown out because that's a [inaudible 00:34:36] of throwing Piaget out because they found out that the children have rudimentary forms of number perception and a few other things and that Piaget was a little bit mistaken about the extent of which he thought babies came into the world with no prior vision or prior knowledge. We wanted to talk about …

We're going to be talking about ideas, about knowledge structures and we find very little of this in … Let me give you some examples but there are a few other people I think who do stuff on this. I'm recently much impressed by rereading Karl Popper. I think Karl the writer … There is no Karl Popper, isn't it? He is Karl Popper. I mean the writer is maybe the educator who has taken this most to heart. That when Popper talks about three worlds. The physical things, then there's the psychological world that these things are related. That's world two and there's world three is this world in which ideas or not … intellectual construct of a reality.

That's the subject we were talking about. Let's talk a little about the developmental and the dynamic of intellectual constructs. Just one little facet of that that's easy to talk about, that have been written about quite extensively is a process that are called disempowerment of powerful ideas. Incidentally, it's there for emphasis. I'll re-mention my book Mindstorms. It was very pleasing that many people read that book. I don't think there were millions but there certainly were hundreds of thousands.

It was most pleasing of all that, I had no idea that teachers would like it and that the most pleasing thing is large numbers of teachers who felt that somehow it articulated what they really thought. It has allowed them to think what they didn't dare to think before setting it to words ... They didn't have some sort of external voice that was saying similar things. The sad thing about that book was that the book was subtitled, Computers, Children, and Powerful Ideas.

All the reviews of the book mostly were good, some were bad but they were all as if it was about children and computers. In some ways, very painful to find a review about this is a wonderful book about children. I didn't think I was writing a book about children. I thought it was a book about ideas. I thought the point about the computer is that it changes the relationship between children and ideas. The ideas that a child can get at different times and if you throw that away, what point is there any more? The point, the central point. Pursing this theme of powerful ideas … let's take an example.

Now taking example that Ulrich has pursued in depth as his PhD thesis and a lot of the related work and that the idea of probabilistic thinking, stochastic thinking. Our probabilistic thinking certainly in the history of [inaudible 00:38:33] is one of the all time best powerful ideas. It's transformed, it's transformed the physics, it's transformed biology and made possible social sciences. It certainly … Have you ever found it powerful, it is powerful. It's not surprising that when people think about introducing new stuff into the math curriculum, they say, let's put in some probability.

Putting in some probability NCTM style is giving some little problems like I've got this one out of one the publications that count how many boys and girls, how many like chocolate ice cream, how many like vanilla ice cream, what's the probability that Mary prefers chocolate, that sort of stuff. You would have no idea from that, that this was a powerful idea. It's one more little ritualistic calculation and when it's found it was chocolate and vanilla and I don't know, it doesn't ... In that vibrant sense, here's something that changed history.

How could we re-… so there's this process. It's a systematic process that ideas as they come into the school world are disempowered. You recognize that this is a process and you can see the stages through it and if the subject could be studied as the kind of opposite of a topic that has been studied by some philosophers of science and some psychologists that the conceptual development, how an idea starts, at some point, it grows more complex. Here, an idea starts complex and grows trivial. If you recognize that, we might … so couldn't we re-empower it and under what conditions could it be re-empowered.

Here are some conditions that can particularly be re-empowered. For example, in the work we've done, and it wouldn't have been possible in dubious times. We have children build robots. Later, or it doesn't matter when it's coming … They build robots with computers in them, sensors, a little program that they would like to do something like go to a light or anything of that sort. Imagine this, how does it go to the light? The next powerful idea that we come to is anticipated by this that we might think the right way to do it is somehow it locates where the light is in X-Y specs, X-Y coordinates.

It plots a path from where it is to where the light is. That's perfectly possible mathematics. However, it's not what really happens. I'm sorry. It's not what children do. There's a another way of doing it which is often snuck in as if it were a little thing that just gets us to work but it's really one of the other all time powerful ideas called calculus which Newton invented which is, you don't have to know that whole path. You just have to think with the law of motion in which at each instant, you know what it's going to do.

You make a little algorithm which says, I don't know where that light is, if I just know it's more to the left and more to the right and it turns a little bit in that direction, take a little step forward and keep on doing this, eventually you're going to get there. That's an incredibly important idea of engineering called feedback. That's a more important idea, is the core of what calculus is really about. It's the core of what Newton did when he found out how to really understand the orbit of the moon and the earth.

It weren't any different from Kepler, of course, Kepler looked at the whole orbit and its properties. Newton said, we don't have to think about the whole orbit and its properties, we could think differentially what happens. It would be little moments and that does it all. With that idea, you can program this little robot to do. Now, probability. What if there's an obstacle, a sort of slipper pathway. Suppose there's a physical obstacle. The robot can still see the light but it goes up against it. Again, you could imagine algorithm and it detects the fact that it's running up an obstacle that we can go back off it, go around it.

You could but there's a terribly simple algorithm that doesn't need to do that. This terribly simple algorithm is just put a little bit of randomness in it. The algorithm for this robot is see whether the light is more to the left or to the right. If it's more to the left, turn left and turn a little bit right. Every now and then make a big turn at random. It will still get there provided you get your probabilities right. Probability of making the turn at random is simply too big and the turn must be too big but there is a right and working with the quantitative probability, you can get … you can make it out with the network.

There's no obstacle, it will make a little funniness in the turn. It will get there a little less sufficiently but it will still get there. If there is an obstacle, it's got a much better chance, hugely better chance of getting through this obstacle. There's a bit of probabilistic thinking, a tiny little situation. It's a powerful probabilistic thinking. Because even more powerful if you now recognize that that's the way nature did it too. All simple printers operate like that. That's why the butterfly belt flutters by. That is why and so the scale will now return it.

The scaling could be a five-year-old can be using probability in a powerful way, probabilistic thinking in a powerful way, even in a quantitative way in the way that it gives a sense of I'm solving the problems in the way that God lets nature do it. I can see connections. That's just a little … By putting it into this kind of context. We get two ideas, two great ideas of mathematics.

The differential idea and the probability idea which I think are the two great ideas that made one mathematics happen which we can patch up and translate into a form of successive … That I call re-empowerment and showing the … encompass to you. If we're looking for the right things to do with making this new math … Looking for the powerful idea is worth it. I'd like … Can I … (whispering)

Male: We'll probably have some questions now. We've got about four minutes and then take questions?

Dr. Seymour Papert: Okay. I'd like to one more, so that's one kind of ingredient. Let's look at our ideals. Let's look at, this is just the same. It's the empowerment, re-empowerment, disempowerment as a kind of dynamic category of thinking about what happened to our ideas and how they're formed. Unless we can do that, we are groping in the dark. The second kind of ingredient which is closely related to this is that the concept that we have introduced early into the Logo called the turtle. Who knows about the Logo turtle? I'm sorry.

Just quickly to some regard, that this idea was that we have this entity. It could be a physical thing or this robot could be one of them or it could be an abstract thing on the computer screen. The important thing about this turtle is that it's a mathematical entity that has a position and a heading and it can be ready to move. Its heading will change, change its heading and it will move in this direction. You can program, once you can a computer in simple ways, you can program this to do all sorts of constructs.

For example if you want to make a square, you program it to go forward somewhere and go about 90 and forward somewhere and right 90 … If you wanted to measure a triangle instead of a square, what you do is to repeat four times that. You repeat three times and you have changed the direction and those people guess which is dropping some of your heads, 60 degrees and you turn 60 degrees. It's not enough, actually you have to turn more than 90 degrees but the difference between that and what happens in the real traditional math class is if you're either right or you're wrong.

You can try it and see what happens. If you think about it and you can explore and get to the right … More important is the fact that this looking for entities that can put you inside the mathematics. This turtle is something you can identify with. You can internalize it. By internalizing this turtle, once you've internalized this turtle, you've got an access to a huge range of mathematical knowledge that you can get by running in your head if not on the screen, experiments with the turtle. That raises an interesting epistemological question about kinds of life.

It's become fashionable under the influence of computers to say we should distinguish between knowing how, that's skills and procedures and knowing that, that's proposition for that but there's another kind of knowing that vastly more important and maybe more deeply rooted biologically and neurologically, [inaudible 00:49:58] knowing somebody … I can get to know a person and I internalize that person. This is the kind of knowing that it's not knowing that or knowing how, it's an important kind of knowing. Children do it, babies do it, cows do it.

This is another kind of dimension on epistemology. Let's have an extra kind of … Look at more kinds of knowing, knowing the thing, knowing this turtle and internalize. You find looking … where do you find that sort of thing. You can find it in literature and odd place that aren't usually connected with … There's a lot of knowledge, there's a lot of thinking about internalizing objects and then it connects with some of our modern ideas about object or programming. Maybe the object, the important thing, again see that it's in this context of the computer and the digital.

It opens up dimensions of epistemological thinking about knowledge and ideas that weren't there before. These are the directions that mathoids. One other thing about that other thing, read this speech … (laughing) I would like to read this part of it because … (laughing) Because it's quoting somebody and this is where Chomsky comes into it. Excuse me, I'm going to quote this ... five minutes. I'm going to quote this. The question, why is mathematics considered hard? … in the Chomsky world, there's a good reason.

It's explicitly formulated by Pinker in his book, How The Mind Works. That's becoming extremely widespread. It's part of a biologization of thinking. According to Pinker, language is easy to learn because we learn it naturally because in the course of millennia, the genes were stamped by language. We've got these innate mechanisms … School mathematics he says is not at a time stamped in genes. (laughing) I'd like to just make the point about the mathoid as an object to create a little … to give another dimension by suggesting a different kind of hypothesis.

That it's not that the genes didn't have time to get changed by mathematics but the mathematics was not allowed to adapt itself to the genes. We don't have genes that make us talk English. We have genes that give rise to the general, create the conditions where language can develop. The development of language is a process of something forming that's coherent with … rooted in the … it makes use of … Now, why didn't this happen with mathematics? The first words happened with some mathematics.

It's all this stuff with Piaget and then … Why didn't it happen with algebra which is what I think that we didn't have an algorithm, we haven't the … because algebra was the creation of grown up intellectuals who made this thing in a form that they thought was the right way. You just have to do it the way that they formed it so it has not been allowed the process of evolution of a mathoid that would be consistent with the generic structures. That's the dimensions of mathoid and now just quickly on two other themes, quickly.

First is I was complaining about schools and of course, it's the school where the [inaudible 00:54:30] got to be when they make changes. The school wanted to change, it had a terrible time getting it in. It strikes me as very amazing that the example of a disconnect of ideas that many people who say we're developmentalists, instructivists who would never tell the children the right answer. What we must do is create the conditions where the children will find it and develop it. That's obviously … a few minutes to it. We need this oversimplification.

Once they formulated this, they go and tell the teachers in the school system. This is the thing that you ought to be … They're not applying their ideas of constructivist learning to the people that really want to change which is the school. This is another thought that we have to find ways of finding for the school to be able to do it. Ideas for that are just made from one and that is again from Piaget, the idea of assimilation and accommodation of that.

For Pinker, assimilation always comes first. In education reform, if you read books like Tyack and Cuban and others, they've led much of the fact that there's great reformers coming up with an idea and the reform wants to change school that change school changes the reform. A great phrase that Tyack said. It's in the Tyack and Cuban book. What's it called?

Male: Tinkering Toward Utopia.

Dr. Seymour Papert: Tinkering Towards Utopia. Now, I think they've got the wrong … We're trying to complain about assimilation. Assimilation has to happen. What we've got to do is to design our interventions in such a way that they can be assimilated and with the design criteria is once assimilated there in the form, now they can be assimilated and they're going to start a disequilibrium inside and give rise to a process.

This is really what I'm trying hard to do to create the kinds of elements of mathematical and other kinds of learning that could go into the school system. The idea that it's going to be assimilated but good. We calculated the time so we're trying to look at the kind of assimilations therefore, in the long run turn into something different.