Digital Learning Technologies: Small Improvements or a Revolution in Learning?

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Well, thank you, Dominik, and thank you all. I would like to maybe first remark on the fact that I am not going to use any slides or Internet-connections or demonstrations and I am finding this increasingly puts me at odds when I am at meetings because there is always the slide there as if people are saying «Don't look at me, look at the text, look at the picture, look at that net, look at the …» I think this is one of the dangers we have to counteract in auditings with this technology that we have to keep a number of aspects of learning close to our hearts, and one of these is the intimacy of personal contatct and look at the person not at the words, or the pictures on the screen. But I think also one wants to look beyond the person. A friend of mine conducted a survey among african children who had not been exposed very much to television. He showed them some television and they used the radio and he asked them, which they prefered. And one of the children said: «I prefer radio because the pictures are so much better.» The pictures in his mind as he listened to a story and could use his imagination. I would like to say many things about that but can't say them all so I will pick on one of them. It is about picturing, it's about picturing the future of learning and of school and of education of children. There has been a vaste amount of talking about how all this computer stuff is going to revolutionize education.

It hasn't as Dominik, I mean, as we all know, in fact, that school has not changed very much. And many explanations have been given like all the parents are conservative, the teachers unions, there is not enough research, the technology is too expensive. All these things, no doubt, they affect this but I believe the major factor is on a different order all together. It is not a lack of research, not a lack of will, not a lack of technology, it is a lack of vision and by this I mean who is thinking about concretely what do you think a child in the year 2020 is going to be doing in learning. Do you really think that the child of 2020 is going to be learning to manipulate fractions and carry through the curriculum that we impose on them in our schools? I am shocked by the extent to which nobody is asking this kind of question, nobody is asking whether we will see radical transformation not any in how people learn or where they learn but even in what they learn, in what that curriculum should be The is almost there is a lot of writing in very general terms everything is going to change, but we say what exactly is going to change our leaders wether they are politicians, whether they are professors of education whether they are teachers very, very seldom are ready to come down to real details and say, well, really, let us call all that in question. And so I think the ultimate source of the conservators on may is in our hands, in the hands of people of the community that I take of you all of us in this room are part of the intellectual leadership of thinking about education and I would like to invite you to spend, say in the next few years, let us say 10 % of your time and of whatever resources you have actually developping visions, what really might it be like. And to think of such visions really is hard work. But when you say I don't think children should learn to do fractions the … would of course say should … saying they should not learn mathematics, mathematics is a part of the human enterprise, of human civilization, well, of course, I am a mathematician, I love mathematics, it is the pinacle, one of the pinacles the achievement of the human mind, but what we teach children in the elementary school is not representative of mathematics, it is not, it is one tinny sliver, one billions in my calculation of the total of mathematical knowledge. Why that particular sliver? There is only one reason, because it is been there always. It was to us determined of some earlier age, we can change it. Now people say, but come on now, you take no centric technocratic people, are you suggesting that because of a technology we should decide what children should learn. Surely technologies should be at the service of the curriculum, it should not dictate it. Well, I agree. Except I think they have got the boot on the wrong foot. Because what we teach in schools is dictated by technology. Namely by technology of an earlier age. It is dictated by what you could teach and what was relevant to people living in a society in which knowledge technology was pencil and paper and maybe tropboard and the teacher standing in front of the classroom.

So I see the new technologies not as dictating what should be learned by young people but as liberating us from what we thaught. We give you an example: This touches … piece of mathematical content but for mathematicians and phycicists and so and among you maybe this seems very natural, for others maybe it does not, but it ought to, because we all have a responsibility for thinking about all sides of the intellectual environment we offer to our children. I have done I have thought a lot about the relationship of these videogames, computergames to children and learning. It is amazing to see how much in mental energy can be liberated by children trying to learn the latest game. … make a list of what they have to learn in order to become real expert of that game, it is make more than anyone would dare put in a school curriculum. It is not hand eye stuff, you will trying learn one of these games and you will see very quickly. These children are really learning a lot. Now, every educator sort of feels envy – if only we could mobilize that energy into their learning what we want them to learn, wow! So they do exactly the wrong thing. They say, well let's inject into this games how to do the multiplication table or how to add fractions or how to do the stuff in the ancient curriculum. Well, my nelegy to that is, I imagine a 19th century transportation engineer trying to improve the way that we move around in horse drawn carriages and he, ah, somebody comes along and says: «I made a great invention, the jet engine» And he says: «Oh, wow, maybe it will help my

carriages» so he ties the jet engine onto the horse driven carriage to see if it will improve the, it will help the horses, of course, it doesn't. It shakes the carriage to pieces. So he powers it down to the point were it doesn't shake the carriage to pieces and then maybe it …(ains) a litle bit now. I think that the way we are using the technology is exactly like that. We are using it to support a school system in a curriculum that is like the stage coach. The jet engine came to ist own with the invention of the airplane and our question is what does the education or airplane look like. So thinking about the games I think a different sort of thing that I said, well, maybe it is since children think these games are interesting and are passioned about them, why don't we let the children make the games? Now, in order for the children to make the games you got to be in a context with the children can acquire enough of the skill needed to design a game, to programme it, to learn something that we don't put in our schools, namely, what it is like to carry out a long term project because you are not going to make a good game in a few minutes, and children can be turned on by that, there is excited about that as playing the games, because they see game making as an important thing as even more important than playing it. The makes of the games are among their great heroes and to participate in that is a, ah, appropriating something modern in cavern edge of the world. Wo what do they learn from that? I have already mentioned a few things they learn. They might learn computer programming, they might learn even more important what it is like to manage a project over time, to undertake a task, a goal, that you can simply realize using the procedure somebody else has given you, it is going to involve you, you are going to run into many many problems and difficulties and you are going to have to find out how to solve them. All these things.

But I would like to just focuse on a different piece – on mathematics. A little piece of mathematics. In one of the, in lot of games as you know, like Mario, I guess we will hear from the creator later, I cant't see him – is he here? – ah, I am looking forward to seeing him again, in some of these games a little figure once walks on the screen, you know, something happens and he has got to avoid an obstacle or jump over, oh well, jump over. This kind of incident arises with the kids. They are going to make this figure jump. So you let in to something that is really very different from what we do in schools too. You think about jumping, well, every child knows how to jump, but hardly any child has thought about what it is to jump, what is the shape of a jump, for example. And so they run into this problem and the easy way to make a jump if you programm it is you run along and you go off like that and go down like that, that's very easy from the jump and they look at it and say: «Hey, that's not a good jump, it doesn't look like a real jump, besides it makes it too easy. A real jump maybe you have got to decide where to take off, because you don't go like that you will go like, well, what isn't go like? Immediately these children, I am telling about 7 or 8 years old children run into the need for a concept that usually you might learn in highschool, namely, the idea of a trajectory, the idea, that a path which you can't see has a shape with a name which has a (purpose), so they start in (countring) a different kind of intellectual framework. How do you talk about this thing? And then not just talk about it, how do you make it? Well, a little while quickly they get into, we might have … this is a time when as I in (wisich) one model of what a teacher would be and this is not this I think trivialization of the change that people refer to as teacher is just a fazilitator. But, of course, everybody is a fazilitator of everything, but this teacher is really teaching something but seeing here is the moment when I can introduce a powerful idea. First of all of a trajectory and then how to think about it, well, let's think about velocities and movements and motion is, there can be a motion like that but then we are laso adding a motion vertically as you jump up and what's it like to add two motions to construct a new one. Now it is a topic which in schools at some abstract high level you meet as decomposition of velocities and those who haven't done this kind of mathematics, well, don't, doesn't worry, I mean don't worry about not knowing it except know is something that is met at quiet a late stage and is rather abstract and difficult but when we think in terms of manufacturing of making velocity is not decomposing them but how do we make a movement. It becomes very concrete and very real for children at a very early age. so you are going to combine a movement this way and a movement that way and it is going to produce that jump and the question is how do you combine them. Well this leads into a different way of thinking about motions and topics that used to be advanced and now become very elementary. It also leads into a concept of a parabola, as this shape is a parabola, and this parabola is going to be produced now by combining a uniform motion this way with a uniform motion plus a uniform excelleration. If you don't know what those words mean, it doesn't matter. My point is, that this is a way of getting at that idea of a parabola and a point I want to make though is that when I say this to math-teachers they say: «Ha» but they don't know that it is a parabola and I say: «How do you mean they don't know it is a parabola» and the math-teachers says: «Well, a parabola has an equation why equals ????? or why equals ???» and I say: «Uh, really? Why is a parabola defined by that equation? I am defining a parabola a different way. If you can find a uniform motion this way with a uniform acceleration this way, it makes a parabola. And that is a parabola. And you don't know how to turn your equation into, well, the point might be, I think the point is maybe very fundamental that we have picked on a particular representation of parabola and through our education system have turned it into casted in concret of the curriculum. But it is a ridiculous and uninteresting definition of parabola. ?Ist? only advantage is that if you think of the parabolas a xpress b y plus c, well a xpress, b xpress, c than with a pencil and squared paper you can plot the points and the teacher can combine, say yes, you have got it or you haven't got it and give you a grade. So our definition of the mathematical concept is defined by what is easy to do with pencil and paper technology. In a different context where mathematics does not consist of putting black ?morphs? on paper but consists of manipulating dynamic ?con tational? objects. You can see a wider range and many different other ways of defining the fundamental concepts. So why should computers dictate the way they are defined wrong. Newton and Archimedes and all the great creators defined it much more in like the way that I am doing it here than the way it's done in schools. The way it is done in schools is a disempowerment of that powerful idea. And what we are able to do is to reimpower the powerful idea. And this is hard work. Finding out which ideas are disimpowered, how to reimpower them, we have got to think through not

just how to make a classroom organization or set up websites or we really have to think about the intellectual content of what the learning is about and go to envisage radical change in the order and form of that content.

Let me take another example. It is another mathematical example. Than I will take a none mathematical one afterwards. In the last few centuries, science was transformed by a very, very powerful idea called probability or probabilistic thinking or stochastic thinking or stochastics. The idea of probability and randomness really changes the way experimental scientists think about experiments and how to it created the possibility of all the social sciences, it transformed physics by entering into ?contemfere?. It is a powerful, powerful idea. Now, go to school and see how probability is discussed. Or look even at the suggestions that are being made for, we have got to introduce new things into the curriculum, like probability. The way in which it is being introduced is, well, probability is a ratio of two numbers and the probability that, äh, I know that you are a woman, we will find out by counting how many people there are and how many are men and how many are women and work out this ratio. Well, this is ridiculous. It is not a powerful idea. It is a little ?ritulistic? calculation. The children using that do not have any sense of probability as a transformer to concept that could really change the way you think about something, that you could really use for a real purpose. So, how do you use it for a real purpose. I will give you one example and I am choosing this example because outside there is that little Lego Mindstorms, which I am very proud to know is named after my first book on children, computers and powerful ideas, 1980. So in the context of those little, of this context where we have got a little computer this size and soon it will be a quarter that size and soon it will be a tenth of the quarter, ah, children have this computer, they build their Lego set and the computer can controll what this thing does, so they are building behaviours as well as structures.

So let me give you an example of something they do. Out there I think I saw demonstrated how you can programm this little computer built out of Lego to follow a black line. Do it a little bit differently. Program it to go to a light. Now, how do you do that? Well, ?ins? a lot of interesting, powerful ideas come in. Ahm, so, if I want them, if I am this robot and I want to go to the light, well, one way is to program myself, you program the robot to find out where the light is and go there. In principle you can do that. Needs a lot of hard work. But there is an extremely powerful idea, ?says? you don't have to do that, because if all I know is, is a light more to the left or more to the right. That's enough. Because if I keep on doing that I just say, well, is it more to the left, more to the right. If it is more to the left I will just turn a little bit to the left and then I will take a little step forward and I will repeat and I will turn. And when I have turned too far and it is now to the right, I will turn back and I will go in a slightly wavy line. Now, in doing this they are using a number of really fundamental powerful ideas. First of all the idea of feedback, the idea that from very crummy knowledge you can get a very crummy approximate knowledge, you can get a very precise result, because all I know about that light is more or less it is more that way than this way or more this way than that way. And yet I will get to the actual place. It is amazing and if we can give the kids a sense of that it is amazing. They get a sense of the power of an idea, of a method. And there are more ideas too in that. There is the idea that's fundamental to the differential calcules that the great Newton invented. Namely, if I want to go there I will break up, I will think of it as little steps, and by thinking of the process as little steps and how it is guided each step that makes a huge difference. But know I have ??? about probability. Suppose you have programmed your robot to go there to that light. And now we introduce another complication, oh, you run into a complication, it is going there and it gets stuck. Why? Maybe major robot in a crew and there is a carpet. Maybe there is an obstacle that you placed. And maybe a teacher does it deliberately and said, well, we are going to put some obstacles here. So, how can the robot still get to the lights although there are obstacles. Well you could write a complicated program, so that it would detect that it is an obstacle and go round it and that could be a wonderful excersice, but, well, an amazing fact is that there is a much simpler way of doing it. That works in a lot and lot of cases. And that simpler way is, just put some randomness into it. So, now, my program instead of being «See if the light is to the left or to the right and take turn that way» it is «20 times I do that and then I just turn it random, I will make a random movement. Now, what's the effect of that? Well the effect is, of course, if there is no obstacle my path is a little bit deteriorated, so, there is no free ???lunches and ist trayed off??? and that's something else they are learning, but I still get there. Provided I don't make the probability too ?much?. Well, so I learned to work ?pontentatively? with the randomness, so that it is going to instead of going directly there in this way, ?we line sometimes aren't to do that? and then go in. I will still get there. But now the big payoff is, that if there is an obstacle I run into the obstacle and I am through a bumping against and then comes my random thing in the program and I turn around and go randomly and then start on my route again. You will get around a lot of obstacles like that, so probabilistic thinking has turned out to be extremely powerful in one important way. You can use it. You can use it to do something which you couldn't do before. And something you wanted to dy, that's a meaningful thing, no school exercise, this is a real thing. But it is powerful in another sense also. And this other sense is that, you know,? it can make us for a lot of things in the world?.

First of all, I have noticed I have done this to a lot of kids and almost invariably, somebody among the kids will point out, you know that's the way that insects do it. Bee fly. ?Flobers? You just start looking at simple creatures, nature has followed the same method. Nature has introduced this use of probabilistic solution to a large number of problems, including the problem of evolution, the problem of how to find the right place to ?his send out? and random a large number of theves and one of them will find the right place and random changes will, can produce the motion towards more complexity in a ?dominium? process,. So all of a sudden something you are doing you can see not only it's ??? you can see, wow, nature itself has used that same method and Darwin and great thinkers have used this to understand the world. So this is intellectual power as well as pragmatic power and this process I would describe as: There was a powerful idea in the history of mankind, in the history of knowledge, it was disinpowered as we tried to bring it into school because of the limitations of the technology we had available

for children. We could not give children this experience of building their little robot. So we reduced it to working out fractions on a piece of paper. We disinpowered it and now the task of the educational innovate is to reimpower the powerful idea to being disinpowered. And it involves as I said ??? work. Identify the right one, find the right sort of context in which they can be done how do you think about it. What is the right way to introduce probability and now I am thinking about that I see that the right way to introduce probability is not first through a fraction, in fact it is not through probability at all. We first introduce what a mathematician would call the idea of random variable, which is usually later on in the probability course, because that's the way we usually start.

Well, that's … äh, äh, yeah … I promised an example that was not a mathematical. You know, there is an amazing movement going on in the world and I don't know about Switzerland, I am ashamed to say I am not being close enough in touch but at a time when it is obvious to me that we are about to see the biggest change ever in the way learning and school happens, in the major countries, like the United Staates and the United Kingdom for sure, the movement is exactly the opposite direction. The system is sort of closing in on itself. Back to basics, let's have more tests. And you look at the test. The tests are trying to casting in concret the curriculum of the past. Why? I think that in 20 years time professors of education will assign to their students of the history of education to former theory of this little paradox. Why is it? And I think it is a complex phenomenon, but I think the essence of it is, it's the twitch, the last twitch of the dying dragons' tail. It is to be understood in the dynamics of systems of bureaucracies, of organizations that when they see the dread the end is coming they are closing in and they make more rules, and they make more castings in concret and procedures and this is what is happening. It is going to change. I talk in a little moment about the way I think the dynamic forces are.

But I think that what we in this context of seeing this casting in concret of the old we have to look for the cracks, where can we make something, something different, where can we make a model, where can we explore very different, fundamentally different ways of learning. And fundamentally different ways of learning does not mean fundamentally different ways of teaching the old stuff. So, I would like to spend the rest of this time on a few concepts that I think, a few other concepts that I think are relevant to help to think about that change. One of them is this, I would really mention, I didn't give it a name, but I think it deserves a name, I think the epistemology of adiational power, of powerful ideas and to think not only that there are some very powerful ideas but this process of the impowerment, re-impowerment, how do you go about it, how do they fit into the whole is an essential part of what we are thinking about. Now, we have to reexamine what we mean by some fundamental issue like, some fundamental concepts like reading and writing, the three r's. I wrote a paper that provoced a lot of heated insult on my head and I said the three r's is this an obsolete goal and how dare, I mean how dare I being quest in mathematics that the three r's in English are reading, writing, I know it is w but this is making phrase on words, writing is and arrrrithmetic. And the three r's are, this is a phrase that captures what education is supposed to be, school is supposed to be really about it, so you can question arithmetic but what about reading and writing? Well, you know, I tell you two kinds of stories: First of all, one kind of story is, I have gone into, done a kind of research of what two people discuss about educational matters. For example about fractions. I have spent several days to looking at everything in a big education library of a big university. What do they say about fractions in education? I did not find one single serious discussion of why we should teach fractions. I found books and books and research papers after research paper on how to teach fractions and how a various ways of teaching them are effective. This is part of my vision story. We are not really considering education as a field is defined is how to teach that body of knowledge that's already been decided by somebody else. Why?

Well, on reading, why do we teach children to read. Silly question? Oh, no, nothing is silly question. That's one thing you are going to teach children, nothing is a silly question. Now, I saw I look and see why do they say we have to teach children to read and there is one good reason that's given, in this case there is a good reason, although people don't write about it too much because it is taken as obvious. Because with the ??? being able to read you don't have a access to knowledge and you can't communicate your ideas. And so, if a child doesn't learn to read at a very early age like 6 or 7 or earlier that child is going to be held back in acquisition to all sorts of other knowledge and learning also to other things. So we have got to hurry up and make them learn to read. So we are so insistent and so anxious about hurrying up and making them want to read, that those children who are having trouble reading get so tense and nervous that they develop the serious epidemic of reading disorders and learning disorders. And there is no doubt, that most of the problem in learning to read is because generated by the anxiety shown by adults when this kid is not doing this at the dates that somebody, who knows who, has decreed as the proper time. Well, it used to be true that if you didn't know how to read at that age you would not be able to get access to ? But this is changing very rapidly and we could make it change even more rapidly. That we could imagine, certainly with a little bit of technical imagination, we could imagine a set up so that children using electronic means could at 7, 8, 9 or at any age people could get at knowledge more effectively than our present day children can get with the levels of reading that we have in our elementary school. So that under those circumstances we opened up these access, this electronic access. We developed more textfree ways of getting at the knowledge. I don't say that children wouldn't learn to read. I think that to participate in our society we do. But we wouldn't be so panicked that they learn to read at 9, 10, 11 instead of 6, 7, 8. It is a question, I am not recommending that, I am saying why aren't we thinking about things like this? Who is doing research or even serious examination of the consequences? Nobody. Nobody, because we are all to scared to suggest something like that, because we are all to deeply imbeded in your prejudice that reading is part of our culture, which it is, no question about that, and therefore children have to learn to read as at an age, but why, why that age, why not twice that age, why not half that age?

Another example, in our American schools these days with the test mania that has being extremely destructive of the whole system, one of the tests is, you give kids a passage, read this and than they have to answer questions about, about the passage. There is absolutely no, lots of kids find that very difficult. I have done this experiment, it is going to be published, not yet published: Same passage, same kids, but instead what has been written ist a video, it is a television, it is a story on a film and wow, kids who couldn't answer that question about the text can answer the question very easily. So, should that if this is supposed to be a test of comprehension and if reading is about comprehension rather than how to spell out those break aways from your attitudes towards those black marks on paper, why don't we why don't we encourage these skills through other media and because teachers haven't got any time to do that because the kids have to learn to read, but you start tearing your hair out because learning to read what does that mean, does it mean to seizering the letters or understanding a story or a exposition or a set of ideas? Why do we have to teach that real part of literacy while our attempt to, our focus on something that I call letteracy, letteracy being this preoccupation with the letters rather than literacy which is a preoccupation all the things that make us think of. An developed mind is what we mean by a literate person. Well, so, I am just throwing examples of how I think that we are failing in our responsibility to ask questions. And no wonder we are having troubles with kids, because kids live in a world where more and more things are in question, they are asking questions and we, the designers and the intellectuals of the education system are not asking fundamental questions about what we are doing. We have to got to reform ourselves.

Now the next, last idea that I am going to throw out, because our time is, that's right I was to talk about five more minutes. I would like to recall something. This is some under your bigger picture of where I think how to think about this whole learning business. When I was a kid growing up, the concept that is today called environmentalism did not exist. The word environment sort of existed, but it meant something much more restricted. We knew about many problems that are now studied by environmentalists. I grew up in Africa and we knew about swell erosion, that was a serious problem, in London everybody knew that the atmosphere was polluted and you had these horrible greens fog and some people even knew it was due to burning sulfurous coal. So we knew about isolated problems to do with the water, the earth, the air, nobody put them together. It wasn't anybodies business to think about all those problems as a whole. Than a wonderful book by Rachel Carson, Silent Spring, shocked the world into one of the major transformations of thinking of the last half century which gave birth to this concept of environmentalism, the environment, and now, there are people whose profession, many, many peoples' profession is to think about this thing, the environment. We have the environmental agent, protection agency is a powerful bureaucracy in the United Staates. I am sure there are similar things in every other country. Now, I think we are at a point where we need to think about learning in the same way. I mean, just as once upon a time we thought of environmental questions ??? here and there and there was nobody worried about the whole. It's so with learning. There are people thinking about school, even than not so much that people think about elementary school and about high school, even than not so much that people would think about math teaching and science. It is all fragmented. And that's only in the school thing. There are people who think about parenting and there are people who are thinking about training of people in industry. All sorts of pieces of the story. Nobody thinks about the whole story, about learning as a whole. But the healthiness of the learning environment. Well, by learning environment mean all the factors that have to do with how people learn. And if you really think about that it opens up a whole range of very different questions, looked at in different ways. I mean let's just start with the ones who are related close to the once who were recognized and look at the boundries.

Once upon a time, not long ago, there was a clear division of labour between parents and teachers about learning things. Mathematics was the business of the teacher and very few parents ever thought about how children should learn mathematics or at what age. You send them to school and teacher worries about that. All of a sudden, tens of millions of parents are now buying software. And they ?ten? on their television set, they read magazines, they are exorted to buy this software or that software which will encourage their teachers from which their children will learn mathematics. Now, I don't to discuss the merits or demerits of any particular piece of software, but what I want to point out to is that people, namely parents here are making decisions about a question that they didn't make decisions about before. And I am not even commenting on whether they are better prepared and able to make those dicisions than the other people, the teachers. I am saying that there is a shift in what kind of issues people are asking. And the kind of decisions that they are making that are going to affect how the children grow up. And I think that this shift showing how we can't afford anymore to think only about what happens in school, what happens at home. We have to be thinking about this in a more wholistic way. Yet, I ??? dare say, you count on my fingers, and maybe it is just zero, the number of people who consider it their professional concern to worry about even mathematics learning over that whole span counting what happens to the pre-school children at home and the children when they go to school.

We need a new way of thinking, a new discipline, a new kind of professional. And then there are other little things like, I know when I was a kid I learnt an awful lot by looking inside the engines of cars and it was very important to me that when the car was broken my father could fix the engine. And sometimes he would even open it all up and do an operation of taken out the carving. All sorts of things that are absolutely outside the scope of what people do today. But I think , you see and this has implications, there is an implication for how I learnt, because that transparency of the technology compared with the ?opassity? of a modern car engine changes the learning environment. Richard Fineman, the great physicist, has a lot to say in a book that every educated should read like you have got to be joking Mr. Fineman or surely you are joking Mr. Fineman. In which he talks about looking into oldfashined radio sets was really important to his own intellectual development. Look into a modern radio set and there is nothing to see. It's a change in the learning environment. Who's business is it to think about the affect on

that on total learning. Who's business is it to protect the learning environment. Now I don't think that we can protect the learning environment by saying, let's go back to the Model T Ford or to the well-radio-set but maybe we can recognize that this shifts are doing something and we think about how to compensate for them, what other things to do, and I believe we are, I think some of them, I think think quest as a kind of activity. I think Lego Mindstorms is a kind of activity is in some ways giving children an alternative way of getting at some of the benefits that are lost through this change in the technology, but although some good things are being done, we are not taking a wholistic view about it. We just look at the good things and say, well, that's great, but we are not looking at the whole thing. I think concept of environmental and learning and the pollution of the learning environment should be very high on our list. A little example and then, that's my last example of polluce and learning environment.

A very wonderful movie was made in England called «Shakespare in love». I wonder if you have seen it. It's a playful story about imaginary story about Shakespare might have written Romeo and Juliette out of his own little love affair and it's playful but it's wonderful and it really gives you a beautiful prospect of into the way what you are thinking about ???, language and poetry and Shakespare and all sort of things. Well, maybe you don't share my view. It doesn't matter. My point is, this is a view, this is sometimes very important, very valuable for kids to ???. I know a teacher of English who wanted to take her class to see this, because she shared the view I have. She is not allowed to. Why? Because the thing is rated «r». Now, why is it rated«r»? Because in this movie there is a ?gratuitist? 30 seconds, even less, 15 seconds of explicit sex showing a little sex act, that has got noting to do with the movie, it adds nothing to the ?imprinzing? merits of the story. Maybe it is good for selling the movie they can show that on the preview things and that will attract more. I don't know. But I think if this is a pollution, that little piece of sex, then that is a pollution of the learning environment. Not that I think it is bad, I mean, I think it is ridiculous to think that teenagers shouldn't, that they will be harmed by seeing this scene now a lot more. But that's not the point, the point is that these teenagers are harmed by being not allowed to go and see it and so I think in this whole story it's pollution of the learning environment. It is just as bad as throwing gases into the air. And so, I just throw that to you as en example of how people do things that are harmfulled to the general learning but they don't fall into anybodies perview, nobody is concerned. Of course, I mean, you might ??? to have a few about movies, but you don't relate that to how kids learn literature, how they develop their sense of themselves, of how school is integrated with the rest of learning and I think that is the big goal we need to be looking at.

I am very proud of that Lego Mindstorms thing and I am proud of it because I think it illustrades for me a way of influencing the learning environment. This is for many years we worked on introducing programming into schools which ?nothing? is a good thing to do but I think it didn't really work out, partly because all sort of stuff about schools and the ways that things are deformed as soon as they get there. But throwing that yellow brick into the world of children has meant that maybe already 20'000 or 30'000 children have written a computer program to never written a computer program before. So, by making an object there is no test and there is no quiz and there is no compulsion but throwing that object out into the world makes a difference to how a lot of kids are learning and what ideas they are learning and certain ideas that it is said kids can't learn to hard – they are just doing it, because we throw that thing out there. And I think there are many other examples of that. I think think quest, I think the Internet, I think the fact that we find an 8 year old kid breaking into a bank's computer files and I know one how did and when he was arrested he said, I don't know what all the fuss is about I only took 500 $, I could have taken 500 million $, but you know a few years ago, 8 year old kids didn't do that kind of thing, not olny breaking in, there was no way in which kids mastered a ?casing edged? technology enough to do a high tech crime. So, the fact it's learnable and nobody taught them how to do that. There is a change in what people can learn, how they learn. A dramatic change, produced by these new technologies and the way to think about them is in a much broader way than introducing computers one in every classroom to help support the old curriculum.