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Audio quality for this video is poor due to technical difficulties.

PROFESSOR: OK, today, political barriers to educational change. "One had to cram all this stuff into one's mind, whether one liked it or not. This coercion had such a determined effect that after I had passed the final examination I found the consideration of any scientific problems distasteful to me for an entire year." Who said that? Einstein, so one of the greatest scientists in the last 300 or 400 years.

So that was the effect of regular school and education on Einstein. And it's not just Einstein. It's a general pattern.

So here, from Manchester, New Hampshire, in the 1930's is how Bruce [? Betiset ?] superintendent describes the children's approach to learning and to reading and interest in knowledge. "In the traditional fourth grades, when I asked children to tell me what they'd been reading, they were hesitant, embarrassed, and diffident. In one fourth grade I cannot find a single child who would admit that he had committed the sin of reading. I did not have single volunteer and when I tried to draft them, the children stood up, shook their heads, sat down. In the four experimental fourth grades the children fairly fought to tell me what they had been reading. The hour closed-- in each case-- with a dozen hands waved in the and little faces crestfallen because we had not got around to hear what they had to tell."

So the contrast is pretty strong. And the question is why do experiments like what [? Betiset ?] did not survive? Whereas why does the education system tend to have an effect such as Einstein described, where he found the consideration of any scientific problems distasteful an entire year?

So reading is a particular example-- which I'll give you another one [INAUDIBLE]-- of

the change and the effect of the formal educational system. So in revolutionary America-- so this is late 1770's-- Thomas Paine's *Common Sense* sold 120,000 copies. And their population then was three million. OK, so that's 1/100th of the population now. So the equivalent of 120,000 copies then was about 10 million or 12 million copies today.

Now if you actually look at Thomas Paine's *Common Sense*, it's written in a language, today, that we would call very biblical. When we read it you use English and we speak English but you wouldn't expect 12 million people to buy a book of that complexity and subtlety.

Now that expectation's is confirmed by many a study about literacy and proficiency in analyzing documents conducted across the United States. So the latest one, it was in 2003, National Assessment of Adult Literacy. So this was published in 2005 by the US government.

So they America in 2003 and they tested three kinds of proficiencies. Prose proficiency, which is comparing viewpoints and two editorials as an example of something where if you have prose proficiency you have document proficiency, which is interpreting a table about blood pressure and any physical activity.

So taking information from doctors and [INAUDIBLE]. And quantitative proficiency, computing and comparing the cost and analysis of food items. But none of these are very advanced skills.

OK now, the percentage of adults who are proficient in each of these categories? 13%. OK, now, 13% is a very, very low number especially considering the level of proficiency that's required, the threshold is pretty low.

Whereas back in 1770's America 10 million, 12 million people equivalent today bought Thomas Paine's *Common Sense*. And probably many of them were not actually literate in the sense that they couldn't read. So that book was read to them. So there was a great hunger for words and ideas and learning, which in many ways we had not matched, despite or because of the vast extent of the schooling system

and educational system.

So suppose you want to change this. You want to improve the situation. You'd like to make education better. What are some of the obstacles? So I'm going to discuss the obstacles in ascending order of difficulty in overcoming.

So another way to phrase, ascending order of how local they are. So the first obstacle I'm going to discuss is one that's local to personal psychology. It's local to how people individually act. And then I'll move to obstacles that are broader in scope. So the first obstacle is what I'll call cognitive dissonance.

So the way to see this in action is suppose you go to someone and you say, well you know, the way that that course is done could really be improved if you do it this way. And you think you've made a perfectly reasonable point, perfectly valid point. But somehow your point isn't taken any notice of. Or it's met with resistance and maybe even hostility.

Now, why might that be? Well, there are many reasons. But one of them is you might have phrased it badly. You might have cursed out somebody's mother while you were doing it. There are all kinds of things that you have a lot of control over and don't necessarily have to do.

But there are some reasons that are harder to control. And that's in the psychology of the person who's hearing what you're saying. So one of the obstacles is this idea of cognitive dissonance. So let's see how that works.

So cognitive dissonance was a concept invented in the 1950's by Festinger, Leon Festinger, psychology at Stanford. And he did the following experiments. The experiments were, he had people come and do this task where they basically just put round pegs into round holes and-- he's a college student-- put square pegs into square holes and triangle pegs into triangle holes.

So after they did the experiment they were then split into two groups. Group A was just sent away. You know, they did the experiment and they left and nothing more was heard from them until a year later.

Now Group B was told, oh, we actually need people to help us recruit more volunteers for this experiment. And obviously they might have problems recruiting people to do the experiment because it was so dull. All you do is put square pegs into square holes. So they said would you be willing to be-- in the experiment-- our assistant in helping recruit people?

So Group A, they just went away. And Group B, they were offered a position as experimenter's assistant and were paid \$20 for that. And Group C-- the same thing. They were offered a position as experiment's assistant but they were only paid \$1.

This was in 1950-ish. So roughly speaking in today's dollars, let me just translate those. So here's a way of estimating the equation.

So in 1950 we still have the gold standard. And the gold standard was \$35 an ounce. So the world price of gold was fixed by Fiat from Bretton Woods at \$35 an ounce. Now it's maybe \$70 an ounce. So inflation is about 25%.

So this is about 400 today. And this is about \$20. So then what happened was these students then did their work, nothing, this, or that, being an assistant.

And then they were tested a year later about their opinion of the experiment. So that was actually the real experiment. So these students thought-- like all psychology experiments-- they were actually helping recruit people for an experiment.

When actually, they were the experiment. They were really the subject. So a year later they were asked their opinion of the experiment, did you think it was interesting?

So these people, they obviously thought it was boring because it wasn't worth it. So a year later these people were asked what they thought. And these people said boring.

OK, now, what about Groups B and C? What did they think? So take a minute or two, try to predict what they were opinions about the experiment were one year

later. Question, yes?

AUDIENCE: So did they have a choice to participate? Were they forced to do this?

PROFESSOR: No, I don't think they were forced. It was the Group B who agreed, or the Group C people who agreed. I'm pretty sure that's right. And I'm sure they weren't forced. So yeah, find a neighbor or two and see if you can predict, what did Groups B and C think after a year or so?

OK, so, what do you think they thought? Yeah?

AUDIENCE: Well, maybe Group C liked the experiment better because they were only trying to recruit, I think they wanted to but [INAUDIBLE].

PROFESSOR: OK, so Group C maybe liked it more. So the question is, who liked it more? So maybe Group C liked it more. So they weren't getting enough incentive in cash and they must have liked it. Any other thoughts, comments? Yeah?

AUDIENCE: Well, it's possible they didn't like it originally, but they convinced themselves they liked it because they were doing this work recruiting for not very much money.

PROFESSOR: OK. So they must have convinced themselves because they were getting enough cash to be happy.

AUDIENCE: I actually have a question.

PROFESSOR: Yeah?

AUDIENCE: So did [? all of them ?] take over? Or are we talking only about those who did it?

PROFESSOR: That I don't remember. That's a good question. I think we're just talking about the people who took the offer.

AUDIENCE: OK, so it was self selection?

PROFESSOR: Yeah, there's some self selection.

AUDIENCE: But if a group came from that, you probably should ask the question immediately

after the experiment before asking them to help assist and then you set the control.
[INAUDIBLE].

PROFESSOR: And they might have done that. I don't remember all the details of it. So they might have done that. And [? some wonder ?] if the control was the Group A. But you're right, that's another good control. And they might have done that. Other comments or questions? Predictions? Yeah?

AUDIENCE: Is this a flat rate or is this a per person?

PROFESSOR: Oh, per person they recruited? No, this was their salary. Yeah, that'd be pretty lucrative, \$20 a pop. Yeah?

AUDIENCE: I was thinking B probably wouldn't have liked it as much as C because they probably would have thought, if they have to pay me \$400 it's really, really boring.

PROFESSOR: OK, so B liked it less on the theory that they were doing it just for the money. They were thinking to themselves--

AUDIENCE: Or also if the reason they really have to pay them this much to get the subjects it must really suck.

PROFESSOR: Yeah?

AUDIENCE: Well, and you can look at it another way. You can say, they're paying me this much money. There must be some intrinsic importance to the work. So you could convince yourself--

PROFESSOR: it could go both ways.

AUDIENCE: Right, exactly.

PROFESSOR: They pay me a lot so it must be really important work. They must have tons of government funding for people.

AUDIENCE: Yeah.

PROFESSOR: All right. So it could be [INAUDIBLE]. Oh, comment?

AUDIENCE: Well, I have to say, I think the process of recruiting people would get you to like it more. Because you'd have to be selling it. And then the question is whether you put more effort into that if you're getting paid more money or not.

PROFESSOR: OK, but the common point is recruiting can help you like it?

AUDIENCE: Yeah.

PROFESSOR: OK, so I would say to me, actually, you were right, actually, what happened is that these people still found this boring. And these people liked it. And basically, at the time this was counter intuitive. And the whole idea of cognitive dissonance was built up to explain this counter-intuitive result, which is why would you like it more when you're paid less?

It is sort of counter intuitive. And it's exactly like you say, which is that you reason to yourself well, if they're giving me 400, yeah, sure, I'd sell my grandmother for 400. You know, that doesn't mean that I don't like my grandmother. But \$400 is \$400.

But if they only give you \$20-- that's option C-- no, of course you wouldn't do that. There must be some reason that you're doing that. So if you're participating in the activity we'll say by doing but don't like it, or at least you try to justify it to yourself. You need some kind of justification. And the justification of Group B is well, I'm doing it because it pays a lot of money.

The justification of Group C can't be that because there isn't enough money. So it must be that it's an intrinsically worthwhile activity. So the opinion shifts.

Now if you remember, I mentioned cognitive dissonance as one of reasons to have people vote when you're originally doing multiple-choice questions. Give a multiple-choice question to the students, say A, B, C, or D. The importance of having them vote and make a public stand is that it commits them to the question and to the answer.

Now they have some public appearance in the one of the A, B, C, D categories. And

they want to know, is this right? So the political organizers know this. And these kind of ideas are old hat now.

We've seen things that consciousness and psychology in marketing. So people will sometimes-- for example-- come around and ask you well, would you mind putting a sign in your front yard for this political campaign? Well, at first they'll say, would you like to give \$100 to the campaign?

And you say, no. I don't really know who XYZ is. I sort of maybe support him \$100. [INAUDIBLE]. So you say no.

They say, OK, well, would you mind putting a sign in your front yard? So now, what have you done? Made a public commitment. All right, everybody who drives by or walks by sees that sign for the candidate.

So now studies are completely consistent with this-- you now do it-- you now support that candidate more. So turns out, what's the key thing in changing your view? Is that you feel you had a choice.

So here, if you put a gun to someone's head and say, put a sign in your front yard. And they put a sign in their front yard, that doesn't change their view of the candidate. The person could refuse or not. It was up to them. If they chose to do it, well, that opens a door to further commitment.

So here, this is sort of like putting a gun to their head. This is sort of like putting a gun to their head. You don't really feel like you have a choice. You're like, OK, whether it was boring or not, who cares? Whereas here, you took the choice. And the ones that did it changed their view.

So cognitive dissonance is very, very powerful. Now, how does that relate to peoples' response when you say, you'd like to change the course? OK, and we'll come to that. Yes, question?

AUDIENCE:

Yeah, so again, Group A then was never offered a choice?

PROFESSOR: Yeah, they were sent away. And they were asked a year later to see what they thought of it. And they said, yeah, it was boring. They're sort of control. I mean, you expect them to say, it's boring.

AUDIENCE: [INAUDIBLE] boring?

PROFESSOR: Yeah, just to check so no one could say, well, maybe people found it really fascinating. You know, because they didn't. So now what happens when you say to someone, oh, we really should change the way this course is done. So now suppose you're at some weak university like MIT or Cambridge or something like that.

Now, where do a lot of the people who teach at these universities come from? Either that same university-- especially in England, that was really notorious in the united justification [? for it ?], which was that our system's so wacky and different, only people who've been through that particular system can possibly teach here.

So how are the justifications? Either the people come from that same place or come from a similar background, similar university background. So now you're not criticizing a system that they A, selected them. Right? The system selected them from a whole bunch of people.

And so by definition, it must be a good system. Also, they've now had many opportunities to make public commitments to the system of the way things are taught, the way things are done. They've taught them in classes, they've participated in curriculum discussions.

They've selected the students that come, recommended the students that would be better or worse according to that system. So the result is that because of years of cognitive dissonance working on people, they are now very, very convinced that the way things are done right now is great. And although it's called cognitive dissonance, it's not necessarily a cognitive belief.

If you ask them, can you explain why it's great they wouldn't necessarily give you great reasons. And this can be very misleading and can lead you into hot water. So

for example, when you say, well, really we should teach this course differently and put in interactive questions so students learn them.

You'll get responses that are almost nonsense. They'll be things like, for example, well, if we don't put everything on the chalkboard how will students know what's going to be on the exam? And yeah, it's a valid English sentence.

But it's not a good argument because there are other ways to communicate with students. You can put stuff on notes. You can say, read the book.

There's tons of answers to that problem. But these kind of things can be offered as just a complete trump card. OK, these trumps have been played, because no one can do anything interactive.

Now, that level of thought that's behind it, no way people would put that level of thought into their research and be successful with research. And how come that's OK and can be sort of convincing in this area?

Well, because it's really not a cognitive response to be made. It's a belief response. You threaten and challenge a person's core beliefs and they're going to come out and react very strongly. And if you try to argue it just on the rational level you'll, actually, pick up angry people. And you won't anger yourself because you wonder why you hate the progress.

So one way to think about those kinds of conversations is A, if they're difficult conversations-- and actually, the reason I write that there is there's an excellent book called *Difficult Conversations*. written by-- I'm pretty sure-- it's from the Harvard Negotiation Project.

And they said, look, every interaction-- and I think this is right-- has three levels. So that would be the factual level, which is just the ideas being exchanged, of should we teach interactively or not? Is there enough time?

There's the emotional level, which is how we feel about these facts. And then there's the meaning. So what does this discussion mean for people? So as an

example, [INAUDIBLE], the problem with a student who's worried about their grade.

Well, you can tell them, factually, look-- about 3% on that problem set is going to be 0.03% of your grade's total points, don't even worry about it. All right, so that's the factual level. You may often find that just the factual discussion is just the tip of the iceberg because there's all this stuff going on.

So what could some of this stuff be? Well, the emotional level is they just feel really anxious about grades. Now, why might that be?

Well, that's where the meaning comes in. The meaning may be that they feel that the grade measures how good they are. And they've always thought they got into MIT by mistake. And now people are going to find them out. If they ever get a bad grade their cover will be blown.

And everyone will know that they don't belong. So it may have a really strong meaning for them, which is rather emotional. Which means the fact [INAUDIBLE] discussion [INAUDIBLE]. So it's a similar thing with the discussion of change in education, is that people will have a factual discussion that seems pointless and it's just frustrating to you.

Because actually there's emotional investment in the way things are done. And meaning, it means a lot to people. This system, it chose them. It's a system they're committed to. And it's being criticized by you.

Therefore, you're going to get a whole bunch of unrealized anger [INAUDIBLE].

Question?

AUDIENCE: So when it comes to changing a single class and adding some interactivity, what are the downfalls avoiding the difficult conversations by asking for forgiveness rather than permission?

PROFESSOR: Nate, that's a good question. So asking for forgiveness rather than permission, one of the downsides is-- I think, in small and moderate doses that is a good idea. Because first of all, no one's going to notice.

Because they're too busy with their own [INAUDIBLE] teaching that that's rather busybody over what you're doing. So you have, definitely, something right away that you might as well use. But if you want to make any larger changes, like for example, take out something that you think isn't so important in the curriculums-- and make room for doing this-- and somebody downstream really wants that.

Well, it's important to have done it beforehand, discuss it beforehand. Because otherwise, if there's emotional and meaning investment in the way things are done, they won't be able to listen and then you surprise them with a factual change.

They won't be able to listen to your factual arguments then, because you activated the emotional and meaning responses. So you want to try to arrange, [INAUDIBLE] those things beforehand and get all those out in the open first. So I would say, for smaller changes, yeah. For larger changes, it's important to have people jointly figure out what to do, which is true of any political change.

And that's why when I deliberately chose the title Political Barriers to Educational Change. Because political barriers has the implication that it's a political problem. It's a social problem.

It's a collective problem. And any collective problems has these issues of what you do by yourself versus what we do in a group or [INAUDIBLE]. Question, yeah?

AUDIENCE: So I'm just a little bit confused about the idea of cognitive dissonance. So is that where the [INAUDIBLE] between the responses of groups B and C?

PROFESSOR: Mm-hmm. Yes, it's that. Oh, so where does the dissonance come into it? I should've explained that. The dissonance is what you try to reduce by changing your view. So in Group B there's really no dissonance because the experiment's boring.

And they did the recruiting because they were paid. There's no dissonance. Here, the experiment is boring, but they don't have the resolution that oh, I'm being paid to do it. So they have to have some way of reducing that dissonance. And they're going out and recruiting people. So the way they do it is they reduce the dissonance

between the internal view and external performance by changing their internal view.
Thanks.

AUDIENCE: Yeah.

AUDIENCE: So I'm wondering whether-- do you know how people talk about how sometimes if you're trying to convince people to do something you try to get them to feel like it was their idea? And it seems like that would be the opposite approach to what you were just saying, which was that you try to get people on board in advance maybe even so subtly that they don't even realize it.

Because I think if you make people feel like they're being threatened and furthermore that like you're deceiving them, but they'll claim to be always kind of on purpose because you felt like you were backed into a corner. And even if they're not committed to it, because it produces them as [INAUDIBLE], or just because people don't like to be fooled, that they don't like to feel like they're taken advantage of.

PROFESSOR: Right. So that's why I would say, yeah. Take advantage of the freedom that you have that everyone sort of [INAUDIBLE] to make smaller changes just on your own.

AUDIENCE: Do you have ideas for how you might go about [INAUDIBLE], if you see people with [INAUDIBLE]?

PROFESSOR: Yeah. And not so much convincing things that it's their idea it's-- yeah, I don't want to phrase it as people think this as a dishonest [INAUDIBLE].

AUDIENCE: Yeah, yeah.

PROFESSOR: It's really you're trying to find collective solutions to problems that you both think are happening, or you all think are happening. So one way to go about that is to say, well, look. Here is a problem I see. What do you think you could do about it?

They might agree with you on the problem. By creating one problem, pretty much generally people will say, yeah, the students are fine with problem set. But when they have to go do something with it, they can't do it.

So you'll get a much wider grievant on that statement than on what to do about it. But you can start there. Say, OK, well, what do you think we should do about it? They may have some ideas. They may accept the idea that, well, this is a serious problem. And it's not clear what to do about it.

But that right away gives you some license to try to [? external?] [INAUDIBLE]. So you say, OK, well, here's one thing I'm thinking of trying. Let's see how it works. So you're not saying, it must be done this way, and this is the only way to do it, and you're bad to not do it.

Say, well I'm going to try this. Let's see how it works. And I'm happy to share the results with you. And you can use that, too.

And so there's another related point to that, which is the-- I don't know what percentage to give it. So let's call it a 10%, 10%, 8%. So 10%, 10%, 8% equals this. So 10% of people will be early adopters. They're really curious about new things. They want to try new things. Let's call them [INAUDIBLE].

There will be, say, 10% who no matter what you do are just going to say, this is terrible. So, the never adopters. And the 8% who are in the middle who will wait to see and will sort of sit on the fence but [INAUDIBLE], but open. They have other priorities, but they're open to these kind of things.

So my rough rule of thumb is, when you're talking to someone, could be figure out which category they're in. If they're in- this is true of political discussions, right? You probably have some relatives in the family where you just agree we're not going to talk about politics. Right?

So, I have them. I'm sure I'm in some people's category of that, too. We just say, we're just not going to talk about that. Because one or the two of us is not going to adopt the view of the other no matter what is said because you just think it's absurd.

So if someone's in that category, don't even spend any time. Just spend your time [INAUDIBLE] category and say, OK, I'm going to move on. If they're in this category, you usually can figure that out pretty quickly, too. Work with them.

And if they're in this category, that's the people you can reach if you do things in a good way. OK, now this is actually pretty large. I think in the '70s this was called the silent majority, was the code for this [? this word. ?] Yeah.

AUDIENCE: Are you ready to be done with this?

PROFESSOR: Yeah.

AUDIENCE: Could you talk a little bit-- maybe a little later-- about what sort of scale changes you're talking about? And also along with that, how much power each individual professor has to design their own course. If you figure out what the prerequisites are for the next course, then I don't see exactly what the problem is doing whatever you want in your course as long as you meet those-- as long as you teach them.

PROFESSOR: So the question is what size scale change am I talking about? Well, it depends. How much freedom you have depends on the change you want to do. For example, suppose you took to heart some of the readings that were for today and you thought that grading was really terrible and you want to just dispense with grading completely.

Well, even if you're teaching all the right stuff, that will raise a lot of of ire. And people will come after you for that even if you're teaching everything right and you're doing all the prereq. Because it will trigger all kinds of factual, emotional, meaning responses in other people.

And it'll go against many, many-- and that's what I'm going to talk about next is-- features of American society to think we must do things that way. So you have less freedom to do something like that, even if you're meeting all the prereqs.

Now, if you want to, for example, use different examples to teach the same ideas, Everyone wants complete freedom. So it really depends what you want to do. Then there's many scales where you can make change. So you may find that there isn't any way to do what I want to do and meet all the prereqs for the next course, because it just means doing way too much stuff.

OK, well now you have a problem of a bigger scale change. How do you get the whole group of faculty or group of people in charge of that area or course to change what was going on and changes the prerequisites, change the overall curriculum. So now, you're definitely going to be working with lots of other people.

There's another sort of dichotomy, which is is the course required or not? If the course isn't required, you have much more freedom. [INAUDIBLE] so your course. If people don't like it, they don't have to take it. And even if other people don't like your course or don't think it's that important, they're perfectly happy, generally, to let you teach the course that they don't think is that important. Because they want to teach their course, which you may think is not that important.

But now the required courses that every single undergrad that majors in the fields take, those generally are guarded more with jealousy. And so changes in those are harder and generally require more consent from other people just because it's considered a shared core of the field. So that's the meaning.

And by changing that, you're complicitly perhaps threatening to share core of the field. Does that answer your question? OK, so what I'm going to talk about after the break-- so this was the idea of cognitive dissonance, and what role-- and maybe just a few, your local group, maybe your department, maybe your school-- difficulties and obstacles and issues that come up when you're trying to make some kind of educational change.

What I'm going to talk about after the break is society-wide features. All right. So American society or say, European-American society in general, that impose really large obstacles in educational change. In some ways, even bigger than this one.

And you definitely want to take your time with this one. But it's also important to take your time with even larger scale ones. And those will be Behaviorism, Taylorism, and the history and the purpose of those schools. And we'll talk about those after the break. It's 9:58 right now. So we'll start at 10:08 according to that clock.

The first barrier, cognitive dissonancy is a-- to a personal psychology. But now we're

going to look at factors that span the individual. I mean, this spans the individual in the sense that it's the common feature of our psychology, maybe of this [INAUDIBLE] psychology. But let's see it in individual people. But they're are also features that are common across-- you could call them social psychology or social tendencies.

The first one is Behaviorism. Behaviorism is also a school of psychology, which, basically in America, grew out of Pavlov's work on conditioning dogs and working on teaching patience by reward and punishment. And in psychology, what it was is it was a focus on outputs. So it basically denied the importance of studying what's going on inside the human mind.

It was correlated with what was called the logical positivism in the Vienna school. So in Europe, around the same time and soon after, was the rise of quantum mechanics. So if you look at quantum mechanics, quantum mechanics was created partly by the Vienna logical positivists in math in [INAUDIBLE].

In quantum mechanics what's one of the fundamental ideas is what's called an observer. You know, where it says, look. Don't talk about what's not observable. The important thing is what's observable. Everything is sort of rigid around observance.

All right, so behaviorist psychology was almost in the same way. It says, look, don't talk about the mind. We don't know what the mind is. It has no separate existence. Let's just talk about behaviors. How does what you do effect what the organism does?

It's a fine way of training pigeons, but it's not a great way of understanding people. But you can see that it's actually dominant in lots of American education. So Behaviorism was actually strongest in America, It was eventually, I would say, demolished as an intellectual movement basically in this space.

I guess the old linguistic department was here. And Noam Chomsky in 1957, '59 wrote the review of Skinner's book on Behaviorism. And that's considered the coup

de grace of Behaviorism. But even then, the idea lives on. And it underlies so much of what goes on in this school.

And you can see that with actually the lively examples of that, given the core. I'll give you one more of that [INAUDIBLE]. So this was a study. This was fourth, fifth, and sixth grade. And they were asked what's six times three.

Well, they weren't having a problem with that, It's 18. They were asked to make a story problem for 6 times 3 equals 18. 80% of the students could not do it. They couldn't make a valid story problem.

Now, what I mean by story problem is a word problem. So they could actually do the multiplication. That was no problem. But to make a problem which used that multiplication, that was difficult for them. Most of the problems they came up with were along this line.

On Monday, Johnny buys six apples. It's always Johnny, not John. I don't know why. On Tuesday, Johnny buys three apples. So 6 times 3 equals 18. There's was a fundamental lack of understanding of what's going on here behind the equation.

So the performance was fine. He said, what's 6 times 3? 18. And so the observable was [INAUDIBLE]. So by the [INAUDIBLE] standards that was fine. There was no problem. And so much of it was on the school. Bacon just looks at the outreach. Whereas, if you actually look into the [INAUDIBLE], that Behaviorists say you shouldn't really do, and ask the tougher [? question, you'll ?] find it actually has no meat. But it's just like tissue.

AUDIENCE: Is the problem here me, or is it we are looking for the wrong outputs? I don't see, per se, how asking students to make a word problem is looking into the mind any deeper than asking them 6 times 3 equals 18 because it's an output that's closer to what we want students to actually be able to do.

PROFESSOR: The thing is if they this, if they produce a correct story as a formula too, then you wouldn't be happy either. So in some way you want to know does this have meaning for them. So you could then say, well, 6 times 3 is 18.

OK, they understood that. Now, I want them to give me the right output of a story problem. Well, I have them memorize a correct story problem. Whenever they see multiplication, do this kind of story problem. And then, if you ask them the question give me a story problem, they would produce the right output. But you'd still be unhappy.

You'd have to ask a different question to figure out if it actually had any meat. Maybe for example you'd say, well, multiplication's pretty similar to division, so let me see if they could make a story problem for division. Or let me give them a different question, which is this one.

Suppose they hadn't had this question before and hadn't been pigeon trained with it. So you could give them that question and see if they understood what really multiplication means. If they just write down 73, you would say, OK, they understood that.

And it would be kind of pointless to try and have them memorize all questions like this. But after they've seen this kind of question, yeah, they might produce the right output. If you just tell them, OK, whenever you see this, one, two, three, four guys here and four there, produce 73 here.

Well, that's different from really in understanding multiplication. So I would say output is not sufficient. So you have to look behind the output. Did that help answer your question?

AUDIENCE: Well, but I feel like you're still looking [INAUDIBLE] but the difference is the process you used to get the students to the point where they can generate that.

PROFESSOR: No. Well, you're looking at the output, because that's all you can look at. But you're not saying if the output is fine, it's-- you're making inferences about what's going behind that. And that's what behaviorists don't want.

You're saying, oh, there's understanding, there's meaning, there's reasoning going on beyond the output. And that's what the Behaviorists don't want to talk about.

They just want to talk about just the outputs.

And that's a fundamental problem. Because real understanding-- focus on just outputs leads to rote learning. And I think that is one explanation for why there's so much rote learning produced in the American education system.

AUDIENCE: Does anyone-- [INAUDIBLE] [? location ?] [INAUDIBLE] making the contributions [INAUDIBLE] like understanding a problem, [INAUDIBLE]. So what's the operation for that that's different from making up problem. Making up a problem requires more understanding, right?

PROFESSOR: Yeah. Making up a problem does require a lot of understanding.

AUDIENCE: [INAUDIBLE] So society wise, you only need a person to solve the problem not make up a problem, right?

PROFESSOR: Well, that's not the purpose of-- so do mean prompt people to just solve problems or make up problems? That can't be the premise on [INAUDIBLE] democratic society.

AUDIENCE: Right. OK. I agree with that. But why should [INAUDIBLE]?

PROFESSOR: Pardon?

AUDIENCE: Who's happy to choose the computation? They know that 6 times 3 is 18. [INAUDIBLE].

PROFESSOR: Well, so it depends. So on the [INAUDIBLE] in many schools there's tests that just test things like that. [INAUDIBLE]. So the No Child Left Behind Act has pretty much mandated that children be tested pretty regularly on their basic skills. And so there's a ton of questions and things like that on these basic skills tests.

So some people care. And these kind of tests are an impediment to making any kind of educational change. Because if you start spending time on things like that, well, then you have less time to practice three-digit by five-digit multiplication.

AUDIENCE: Now this [INAUDIBLE]. We should say [INAUDIBLE] point first, and then from there break it down to the [INAUDIBLE] much more [INAUDIBLE] than [INAUDIBLE].

PROFESSOR: That may be true. So the comment was that maybe it's better to try something not so hard as making up a story problem. Identify--

AUDIENCE: [INAUDIBLE] the [INAUDIBLE] that we need.

PROFESSOR: It shouldn't be that hard.

AUDIENCE: I mean, we're on a skill, right?

PROFESSOR: It shouldn't be that hard, but it is hard if you've just done drill.

AUDIENCE: Yeah. If you start so low--

PROFESSOR: Yeah. I agree. So it's not saying that all of a sudden now-- I'm not saying all of a sudden now you should ask what we're doing with this question how to make a story problem. But this is used as an example to show how far away we are from where we'd like to be.

So Behaviorism is, I would say branded reward and punishment, pretty much rampant in American society. In discussions of merit pay for teachers, OK, should we give teachers higher pay if their students do better on tests from No Child Left Behind?

So that is the assumption that you want more output from the teacher in that [INAUDIBLE]. You just pay more money. You give them more pigeon food. But there actually maybe other reasons going on, there may be completely other factors besides input output.

For example, maybe teachers think we shouldn't be teaching the test this way. Maybe there's all kinds of social consideration which aren't included in just paying people quote "meritly." So you could see how rampant it is because when you say, oh no, we shouldn't do that to teachers, people think you're crazy.

They say, well, of course we should-- and then they make a really, really long argument for why we shouldn't. So the default is, yeah, everything should be paid according to results and rewards, and rewarding according to result. Yeah.

AUDIENCE: I'm curious about what you think-- because I do think that there is no question that in our society things in which we give respect to and value as a society do get paid more and [INAUDIBLE] to have more perspective as we [INAUDIBLE] our educational system is that we don't pay our teachers anything and don't respect them.

And that's why very few people actually consider that as a real career. [INAUDIBLE] you know, [INAUDIBLE] to actually consider teaching at my school. Very [INAUDIBLE] rate. And that's because it's not respected. It's not considered a challenging [INAUDIBLE]. But don't you think that the amount of money that people get paid actually does in some sense request our respect for them as a society?

PROFESSOR: That I agree with. So there's the meaning [INAUDIBLE]. Yeah, there's meaning associated with the salary. So the problem, what's wrong with merit pay is that the meaning is that you're competing with other teachers. I'll give some money to the schools and say, now dole it out among your teachers. And the one's who do best--

AUDIENCE: Yeah. No, I think that's [INAUDIBLE].

PROFESSOR: But I agree with you about increasing the overall salaries for teachers. And it's exactly right what you say that it's not respected as a profession in this country. And as you say, people who get a Ph.D from MIT are not likely to teach in high school, which is, I think, sad. But it doesn't have to be that way.

So in Europe-- so George Collier, one of the greatest mathematicians of the century, he taught at a Swiss high school. It was a considered a very respectable position and profession. It's a serious profession. It's really important. Whereas, that's pretty much unheard of here. And [INAUDIBLE].

So it's a combination of respect and salary. And related to that, autonomy. So teachers here in America generally have the least autonomy compared to, say,

Western European countries. So one way of measuring that is just how much free time teachers have to do curriculum [INAUDIBLE].

So think back to your own high school. How many classes did your teacher teach? Typically, six a day. I mean, I'm exhausted if I teach two classes today.

Because it really takes energy to teach a class really well, think about it, prepare, answer questions, follow up with what happened, and make references. Teaching six times a day is absurd. And all you can do is just try to survive.

So that's, again, another barrier to educational change. So that is barrier number two which is-- the second we'll call the [INAUDIBLE]. So it's the focus on outputs and reward and punishment. And then the next barrier is another social wide factor called Taylorism.

So Taylor-- it's related a bit to Behaviorism. So Frederick Taylor was a mechanical engineer. Let's see, when did he live? About 1850ish to about 1915 or 1920. 1856 to 1915. So what he did-- he's the originator of time and motion studies.

So time and motion studies watch how someone, for example, is riveting bolts onto a car. And you watch every single movement and you optimize it. And you say, oh, actually if you have the screwdriver on this side, well then when the car door comes down this way you can do this with much shorter movement than trying to do that. So they said you can break every task down with a lots of little little fragments you can optimize. Now, this basically took the whole country by storm in the 1910s or so.

Now, how did that happen? Well, this was a time of industrial unrest. And unions were striking demanded higher wages. And there was the Interstate Commerce Commission, which regulated the railroad fares.

And so the railroad attorney, Louis Brandeis, later Supreme Court Justice, argued the in front of the Interstate Commerce Commission, well, actually we don't have to raise fares. And we can actually give the unions some of what they want without doing any of that provided we implement Taylor's system.

So the idea of Taylor's system was a way of basically trying to prevent the unions from striking, but not distribute any of the wealth for management, but just make things more efficient. So it was what we now call the Cult of Efficiency. And this Cult of Efficiency I would say probably could only happen in a frontier society, like America.

So there's a completely fascinating book, which I highly recommend reading, *The Great Frontier*, by Walter Prescott Webb. So what he looks at is he looks at the effect on European society of the European discovery of the Americas, so around 1500 BC. Columbus sailed and all the explorers were going a sail.

So what happened? Well, before 1500 Europe was extremely crowded, lots of people, very few resources, very little land, pretty much deforested, not much fuel. And so it was a hard place to live. With the discovery of the new world, that switched. There was now a ton of land and not enough people, especially after the Indians all got small pox and died.

There was a ton of natural resources-- wood, minerals, eventually oil. So around 1500, so the world society changed. At least the European society. And with it, changed conceptions of how society should work.

And in the frontier societies, basically everything was there for the taking. You just had to work to get it. So in a frontier society, basically work was a religion. That was the religion of a frontier society. And you can still see that in America.

How many weeks of holidays do people have completely guaranteed? I think zero. And whereas in-- for example, England, I think it was four weeks, maybe statutory minimum. In Germany, it's five or six weeks.

So in the frontier society, work will be your religion. And it's likely to be placed where ideas such as Taylorism will grow, and sprout, and thrive. So Taylorism spread throughout the entire country, including to the schools. And you can still see it in school. School is considered a factory. And the inputs are the students. And we want to do that as efficiently as possible. Think class size, giant buildings to

[INAUDIBLE] to produce more product at the end.

So this is one of the early examples of a Taylor school. The Platoon School. So this was an elementary school. What they did was they-- this is absurd. They enrolled 10% to 70% more children than there were seats for in the classrooms. So [INAUDIBLE] efficiency.

This is done by dumping the 10% to 70% on the playground, into the auditorium or basement. So by keeping all the children rotating from room to room, teacher to teacher, so that the same 10% to 70% [INAUDIBLE] way longer than 30 consecutive minutes to get into classrooms.

So even the 6-year-old children have 6 or 7 teachers a day and as many as 12 or 13 in some cities. And teachers handle as many as 400 people through the day and 1,000 a week. So the terrorists came to the school and said, hey, look, these schools-- it's all very relevant to have small schools for people, but really, it's not efficient. Look, there's all this inefficiency you could squeeze out of the system. And so you can see probably MIT's going to be going through something like that with the budget cuts, all the [INAUDIBLE]. And trying to squeeze the life-- I mean, the inefficiencies out of the place.

So what they said was they said, oh, look, there are all these rooms that aren't being used. You have the gym that's not used all the time. There's the lunch room that's only used at lunch time. That's crazy. There's an empty room there. There's the playground that's only used at recess.

What we should do is we should rotate the kids all the way through. And you'll actually see that in schools now. Many of them have lunch period that starts at 10:00 AM, and the lunch period goes till almost 2:00, because it's a much more efficient use of the lunch room.

But ironically, they had to cancel recess, because recess is inefficient. Recess is not efficient for doing standardized test problems, so you guys will see that as well. So again, they called it efficiency. That was back in the '20s [INAUDIBLE]. It's from

Raymond Callahan's book called *Education and the Cult of Efficiency: A Study of the Social Forces that have Shaped the Administration of Public School*. It's about Taylorism in the public schools.

But it continues to today. In *No Child Left Behind*, you can see is a perfect example of it.

[INAUDIBLE] wrote, he said, "The long lines of marching children that look to be like nothing so much as the lines of uncompleted Ford cars in the factory, moving always on with a screw put on or a [INAUDIBLE] tighten as they passed-- standardized, mechanical, pitiful. When the factory system carried into the public school, which needs only the closing time whistle to make complete [INAUDIBLE] with giant, great industrial plants."

So there you have another fundamentally important social factor. [INAUDIBLE]. So behaviorism and Taylorism are sort of lumped together. Which is the joining of the school and the factory and the educational system and the social order. So that I'll call the social history of education.

So education-- and America was one of the leading countries in this, in making schools free and required-- compulsory free education. [INAUDIBLE] public school.

So this-- in Massachusetts, actually-- our state was the leading state in American [INAUDIBLE]. And so Horace Mann in the 1840s-- he was one of the leading educational reformers. And he was arguing to businessmen. OK, you really should be willing to have higher taxes to make schools free and required.

Now, why would businesses want to part with their profits to pay for schools? But he says, look, there's all these benefits from schools. The schooled workers are more docile and quick in applying themselves to work. They had better domestic and social habits, you know, punctuality and fidelity. They have higher punctuality and fidelity in the performance of their duties. So basically, he was arguing for school as a method of social control.

Now, there was a strange feature in my high school, which I never understood till I

actually read about this. History of Horace Mann called the School of America, which was that-- so I experienced this first-hand.

One day in my high school, this racist student attacked me and called me nasty names. And so when I fought back-- and we sort of fought to a draw, which was good because he was trying to do serious damage.

As a result, the school policy was that whoever was in the fight was suspended for three days. So we were both automatically suspended, and then had to go to court to figure out who was really at fault. But by then, of course, I'd already been suspended for two days.

So I was suspended for three days and I got to find out, what are the policies when you miss school? So it was very interesting.

So first of all, if you're late to school three times in a quarter, then you fail for that quarter. If you fail in the second quarter of a semester, you fail the semester. If you fail in the second semester of a course, you fail the entire year. And if you failed a required course, like English-- math or English required-- then you failed the entire year and had to repeat the whole grade.

OK, so they were very, very, very sticklers about punctuality. But they didn't really care what your grades were that much. You could get C's and D's on tests and you'd do much better than if you missed four days of school.

Now, my teachers were nice in this case. Said, no, don't worry about it. Good thing you fought and stood up for yourself. We won't do any of that stuff. So it was always puzzling to me why punctuality was so much more important in this public school, which was supposed to be one of the leading public schools [INAUDIBLE], than the actual grades you got and how much you learned.

When I read the history of Horace Mann, I thought, oh, yeah. That actually made perfect sense. The purpose of the school wasn't necessarily to teach people to think and really understand. The social history behind it was to produce people who are basically docile workers for the factory system, which was just coming around in the

1840s.

So there were many comments along those lines. One of the arguments also for the school was similar. It was a resolution that the best police for our cities, the lowest insurance of our houses, the permanent security for our banks, the most effective means of preventing pauperism, vice, and crime, and the only sure defense of our country are our common schools. They mean the public, free schools that are required.

So again, it's seen as a defense of property, basically. This was true-- so when I say America, it's not just America, actually. England in 1870 passed an education act that required public schooling. [INAUDIBLE]. And the arguments in England were almost exactly the same.

"Would not the policemen be better employed in assisting the work of the school master by collecting [INAUDIBLE] for school attendance the willfully neglected children who are [INAUDIBLE] recruits for the great army of crime."

We wanted to prevent the working classes from engaging in those vain strikes which end in 99 out of 100 leaving them in worse condition than before. We wanted to keep them from habits of waste and improvidence that some knowledge of the succession of events in life, such as education could supply.

So in other words, education has a class role. So that history of education, it still permeates it. And people were very open about this. These weren't secret documents that people wrote in their conspiratory council. These were openly discussed, saying this is why you should pay for schools.

I would say it was even quite a soph-- reached quite a sophisticated level. So William Whewell, he was master of Trinity College, Cambridge, in the 1860s, I think. So when he was a university professor, before becoming master at Trinity, he was commenting on the difference between the European and the, say, English and American educational system.

And he said, well, actually, they had [INAUDIBLE] problem in Europe. And the problem [INAUDIBLE]. So he was recommending the teaching of mathematics. He said, "The mathematical doctrines were fixed and permanent. No new system of geometry can supersede the old. Not only so, but even the old books remain in use."

So now contrasting that, "The fixed and constant nature of mathematics was not likely to promote the critical spirit [INAUDIBLE] France and Germany, where too much attention to the more provisional and contentious observational sciences had been partly responsible for the imminent general hostility to the existing institutions in their country."

So in other words, we should teach mathematics because it has one answer. [INAUDIBLE] conclude about society, too. It has the one answer, which is the society we have.

Whereas, if you teach observational sciences, social sciences, people might start questioning way too much. So there was not just schools, but what should we teach in our schools? So that history is very, very hard to overcome because it's so deeply embedded into the foundation of a school. We will find its purpose is like that. Such purposes keep creeping up whenever you try to change things. So there are all kinds of things that are crazy in the schools that we do that you don't necessarily need to do in the school.

For example, grading. Why do schools have to grade? People think, oh, well, how will other people know?

If other people want to know what students can do, let them worry about it. Why does the school have to do that? Sure, it's school. It could tell students, look you're not learning this idea very well, you could spend more time on that. You're learning this idea really good. You don't need to spend any more time on that. That kind of evaluation, for the student's benefit, is quite useful. But why should that be publicized to other people?

Well, those are two separate questions, but they're automatically conflated because-- partly, the purpose of the school is to get people to accept their place in the society.

There was a very interesting experiment along those lines. I don't know if you know it. It was blues eyes, brown eyes. So this is related to tracking and grading.

So I don't think you could do this experiment today. But what they was they took-- I think it was third graders. And they came into the class and they said, OK, you third graders. We've just found out that the blue-eyed children are more intelligent than brown-eyed children. And so we're going to have to teach them separately. So they then separated into two classrooms and they taught them exactly the same stuff.

And then they tested them a while later and they found the blue-eyed children did much, much better than the brown-eyed children. So sure, the test results must have been correct.

Actually what they did is afterwards they said, actually, no we fucked up-- sorry.

[LAUGHTER]

We screwed up. And actually, we got it backwards. It was the brown-eyed children who were more intelligent than the blue-eyed children. So we had to switch the classrooms. So they switched the classrooms. And of course, they taught them exactly the same stuff. And what do you think happened [INAUDIBLE]?

They flipped. That's an example of the effect of tracking and grading. So what's the result of that is that, well, students then accept their place. They think, oh, yeah. I am the dumb student. I am the bad reader. Oh, I'm just not so good at math. It's my fault. Rather than-- well, it's the way it's taught. It's that I came from a family where we just didn't have much money, even for food. And the society just didn't provide that, so I was hungry every day. So there's all kinds of social explanations which you're taught not to look at.

And even the very problems that are done in school tend to reinforce the social

order that we have. So an example of that, to really show how strong that tendency is, is look at the problems that are done about percentages. The percentage problems are always of the following form.

Johnny has \$1,000 which he lends to Jane at 6% interest. How much interest does Jane pay after two years?

Well, there's many interesting features about that. First of all, Johnny makes the money. The guy has the money and not the woman. The woman is the borrower. So now, with feminism, we've made it so that Jane can have the money. But you haven't changed the fundamental problem, which is that the problem is reinforcing the idea of money lending. [INAUDIBLE].

What about the following problem, which you never see, which is also [INAUDIBLE] interesting percentage problem? The hourly minimum wage is \$7 an hour. If somebody works 40 hours a week, what's their salary?

OK, it's this much. It's roughly \$14,000 a year. What percentage of the federal poverty line is \$14,000 a year?

That's an equally interesting percentage problem, but it has a different social message. So the schools have chosen, basically [INAUDIBLE] social pressures that push towards one kind of problem, one kind of grading, one kind of system. And this is despite what people know about these things. So blue eyes, brown eyes experiment shows what's the detrimental effect [INAUDIBLE]. Many people say, well, actually, [INAUDIBLE].

Another example is tracking. So tracking where people know that it's harmful. So a friend of mine in New York, he went to an elite private school. It's a small, elite private school.

And one year they decided to introduce tracking. So tracking is advanced math, median math, OK math, and remedial math. And after a year, there was a parental revolt and they abolished it. The parents said, this is outrageous. We're not paying \$25,000 a year for you to tell our kid that our kid is not intelligent. Get rid of it.

Whereas, it's considered perfectly acceptable to do that to kids in public schools. So people know, yet the thing goes on. So whenever you see something like that happening, you can bet there's some really deeply embedded social history-- the purposes of the schools.

And related to the social history is the social history of our society. So these tendencies, they're not immutable. All social factors have changed in the past and all of them can change again. But in order to change them, it's important to be aware. You have a question?

AUDIENCE: Yeah. I just had a question with the whole concepts of getting the grades, which I can see is a benefit in some ways. But I feel like [INAUDIBLE] to just stop grading children, I feel like at least at the level of college acceptance, there's still going to be some level of evaluating the children. And eventually, it's just going to be that some other form of evaluation is leading to this separation, even if it's not just by numbers. Saying [INAUDIBLE]. And is there any way you could really deal with it without having grades?

PROFESSOR: Well, I think you've identified the fundamental problem, which is the competition. So it's sort of like the water bed. If you sit on one side of the water bed, the other side goes up. So if you reduce the competition in one place, it might increase in other ways. So for example, you have no grades in high schools, but then you have a really, really high stakes university entrance exam, which is not necessarily the ideal solution.

I think the ideal solution is that you make good universities accessible to all people. Or, for example, if you make it so that you don't need a university degree to earn a decent salary.

AUDIENCE: But is that ever going to be possible?

PROFESSOR: Well, I always quote Margaret Mead on that, "Never underestimate the power of a small number of people [INAUDIBLE] to make social change." And not just a small number, but people in general.

So all things that we now think are absurd and just horrible were once normal. Slavery was considered absolutely normal. And in fact, the view of the inferior races [INAUDIBLE]. But all these things that we think are horrible now-- torture-- are now considered just beyond the pale because of social [INAUDIBLE]. So my main point here is that these are structural, fundamental, large issues. And they require structural and large society-wide changes to fundamentally change them.

But it goes both ways. The schools themselves produce people who reinforce the social structures. So if people had come through the blue eyes, brown eyes experiment and they feel themselves that they are not worthy, they're less likely to try and make a social change to make a just society. So it goes both ways. Improving the schools and the educational system improves the society. Improving the society improves the schools.

AUDIENCE: I was wondering if you could take advantage of that blue-eyed, brown-eyed thing, like to say-- one could say something like, oh, people in that class always did really well in their future physics classes. And then everyone could just be like, oh, great. [INAUDIBLE].

PROFESSOR: It's a great point. So the point was, could you take advantage of the blue eyes, brown eyes experiment to just tell people, look, everyone in my physics class does great. And so just, actually, make people do well?

There is actually a fair amount of data that does work. So [INAUDIBLE] wasn't phrased in exactly that way, but the example I'm thinking of is women's colleges. So a large portion of women in science Ph.D's come from all-women's colleges. And I think that's partly that effect.

In the regular society, women are generally told, look, [INAUDIBLE] the Barbie doll that was taken off, [INAUDIBLE] Barbie doll that for a while said, oh, math. Math is hard. I don't do math, or something like that. That's what it taught. It's really amazing that they thought they could do that.

So there was huge outcry and they had to take it-- some people did spoofs. They put that as a Ken doll and they put a big, deep voice in the Barbie doll just to play on that. But that social attitude does permeate the society. And it's much less in the all-women's colleges. So places like Swarthmore, Bryn Mawr, and Smith where women are-- it's just expected. Of course you're going to do well in science. Everyone around here does well in science. It's not considered anything special. It's considered a good thing, but it's not [INAUDIBLE] to women.

So they already took away the blue eyes or the brown eyes and just put everyone [INAUDIBLE]. So I think that is a reason for not criticizing kids. When you're raising young children or teaching them things, don't criticize them.

And same with grades at a university. Grades should be so the students can figure out what they need to learn more of, but not as a way of making them feel bad. That's so hard to do when people have been graded or degraded for so long.

Question, yeah.

AUDIENCE: So I wanted to go back to your earlier point about competition, how it takes it away from one place and it ends up another place.

PROFESSOR: I don't say it's conserved. But you have to think about the whole system. Yeah, so I agree with the question.

AUDIENCE: [INAUDIBLE]. Not only it doesn't scale because of limited resources. You can't keep everybody in teacher one on one. It would be great if it took, but the system won't work that way. We won't have enough teachers. So there's always going to be competition for resources. I just want to--

PROFESSOR: Well, OK, so the question of competition. So let me close with one quote, and then I'll come to your question. OK, so it's a good question.

So to continue the rest of what Einstein said. So remember, before Einstein said that one had to cram all this stuff into one's mind, whether one liked it or not. "This [INAUDIBLE] effect that after I passed the final exam, I found the consideration of

any scientific problems distasteful to me for the entire year.

It is, in fact, nothing short of a miracle that the modern methods of instruction have not entirely strangled the [? whole new ?] curiosity required. For this delicate little plant, aside from stimulation, stands mainly in need of freedom. Without this, it goes to wrack and ruin without fail."

So I hope that when you're out in the world, when you're teaching and raising your children, that you find ways to make more freedom in education. So that when the students actually that you produce improve the society, and they then, can help you improve the schools and the rest of the education system.

OK, your question about competition. It is a fundamental one. And about competition for resources, you have to really-- so make a radical analysis. So radical in Latin means to the root. So you have to get to the root of the problem. So the root of the problem, you can see it in the extreme case of India where there are so many people and so few comfortable jobs, and the route to the comfortable job is in education. That's there's intense competition for tutors and all this. Not because people want to learn, but because that's the means to actually not starve on the street.

So what that shows is that not everyone wants to learn with a tutor differential equations. But a lot of people are learning differential equations with a tutor because that means they'll get a degree, which means they can work in investment bank, which means-- well, it used to mean that they would be comfortable. So part of the issue is of redistributing the wealth in the society, so that you're comfortable whether or not you had a tutorial in differential equations or one-on-one tutorial.

Then, when the fears are taken away, people are much more likely to do things for intrinsic reasons. So the people who really are interested in that, then do that. The people who are really interested in teaching that will teach that. And you'll have a redirection of social resources in much more productive way.

But that requires, for example, the value of, say, guaranteed income, guaranteed

health care. Maybe even guaranteed basic schooling for everyone, so that those things are features of competition. Yeah.

AUDIENCE: But the system based on competition is quite self-regulating, right?

PROFESSOR: I don't know about that. So a good example-- is the system based on competition self-regulating? I'm not sure about that. I mean, the mortgage derivative market is a great example that-- actually, what happened was-- you can think of it in electrical engineering terms. You had-- let's do it under continuous time.

So you had some sort of slow, pokey banking system with feedback loops and the poles were [INAUDIBLE]. [INAUDIBLE], nice decay constant. And then, the competition to make more money quickly-- well, one way to make more money was to trade [INAUDIBLE]. What did that do?

It increased the gaming of feedback loops and [INAUDIBLE] the poles this way. And eventually, some of the poles crossed the axis and you got huge nonlinear oscillations, which grew to-- huge oscillations grew to nonlinear [INAUDIBLE] and broke a whole bunch of the world banking system. So it's actually not necessarily true that competition is self-regulating, because there are all these nonlinearities and feedbacks and delays in the system, there's no guarantee of that.

And one of the harms of the competition is it puts people against each other. And what'd you much rather have is people working together and helping each other. Because as studies quoted by [INAUDIBLE] showed, that actually-- if you want it to go a high level, [INAUDIBLE]. That's how it happens. Not through competition and dog-eat-dog, but people cooperating and sharing knowledge.

And what we wanted to do, I would say in our educational system, is shift it more towards there and free people [INAUDIBLE] for creating the [INAUDIBLE]. Instead of [INAUDIBLE].

AUDIENCE: So we don't determine the pay of different people in the society based on the competition, what do you propose? Do you propose that somebody else decides [INAUDIBLE]?

PROFESSOR: Well, we already have all kinds of ways. I mean, you can have regulations. You could, for example. Say, I mean, income tax is a social way of deciding what's worthwhile and what's not.

You could say, OK, we're going to tax peoples' income the 99%, beyond 200,000. [INAUDIBLE]. And we're going to use that money to pay teachers more. That's a social choice because saying the teachers' salaries are this.

If you think it's a worthwhile thing to do we could say look, we think bridge building is really important it revitalizes the [INAUDIBLE]. We're going to pay people to do that. Those are social choices, just like anything.

It doesn't have to be permissive. All right? So we can change our educational system that way.

The barrier to it is that our thoughts are limited by the educational system that we went through. So in one way that's bad news, because there was this giant feedback loop keeping things the way they are. On the other hand, because there's a feedback loop, the educational system affects the society and vice versa.

Well, it means you can work anywhere on the feedback loop you want that you think is interesting. You could try to improve the society directly. You could try to improve the educational system in [INAUDIBLE]. You can try to skip the feedback wherever you see it. Insert something good in here. And you improve things for everybody that way.

OK, so if you could fill out the question sheet. [INAUDIBLE] put on the website who [INAUDIBLE] as well as referenced [INAUDIBLE]. And next time we'll have a summary of all of the second [INAUDIBLE] as well as questions from you. Because I know I have a few questions that I have to answer plus [INAUDIBLE]. So we'll try to answer all your questions [INAUDIBLE].

Answers from lecture 10 to questions generated in lecture 9.

PROFESSOR: OK, lots of questions from last time. So I won't answer all of them because otherwise we'll probably spend the entire time just on the questions from last time. Which maybe I should have anticipated since it's a central topic and one that connects to not just education, but directly to society, the topic on political barriers to educational change.

So I'll answer some of those. But then I wanted to also give you a chance to ask any questions that have been unresolved that have come up in your teaching or that you think might come up in your teaching. One of my old teachers, Don [? Knuth, ?] always reserved the last session for student questions. And I think it's a really good philosophy to tie everything together, tie all the loose ends up. So I call it your turn.

OK, but part of your turn was answering some of your questions from before. Is social education a bad thing? And so the comment was, I'm still not convinced social education is a bad thing. Obviously it gives a lot of control to whoever gets to make the decision of what constitutes a good citizen. But some of the social agendas in public schooling were good. For example, diversity, recycling. And that's true.

So I don't want to be misinterpreted as saying society is a bad thing. I think society naturally educates people. You pick up your values from people around you. Your parents give you ethical norms. Schools give you ethical norms. And I think it's exactly what the question said, it said who gets to decide? Is it some group of elites who decide or is it the whole society collectively deciding what is good for everybody.

And what's good for everybody may not be one thing. It may be the decision is well, different people need or want different things. And we think a good society is based on the idea that people have freedom to follow their interests.

And also, some required work that everyone need to learn, for example, reading. But then what you read may be up to you. So yeah, I don't think all social education is a bad thing at all.

I think all education is social. There's no way to avoid that. Inherently we're social

animals.

And it's the question of what's in that education? And it's the same thing, political barriers educational change. It's not that politics is inherently a bad thing.

The question is, what kind of politics do we have? And how can we make that better and more humane? So for example, I think recycling is a good example of making things more humane.

OK, if competition demotivates some people does it motivate other people? Does eliminating competition reduce maximum performance?

Other than the studies referred to by Alfie Kohn, I'm not sure if the answer to that is known. I mean, there's certainly studies on how, for example, competition leads to a lot of waste. The classic example in economics is suppose you-- and this was actually a real example-- give people 160 acres of land-- I think that was the a 1/4 plot-- or 640 acres of land way out in the west.

And the rule is whoever gets there first gets to claim that piece of land. And you get there and you stick posts up and you put a fence there. That's roughly how the Homestead Act worked.

Well, the problem with that is that it does cause a lot of waste. Which is that tons of people might run out and chase after that land. And make a whole bunch of effort buying train tickets, go on a wagon with their whole family out west. But only one person gets the land.

So a whole bunch of people actually put in a lot of wasted effort. So that's a classic example of how competition can be quite wasteful. Other examples, where exclusive rights do that, or patents. So as is the case, a patent's only given to one person-- or the inventor-- and you have 15 people or 30 people trying to invent something.

So the more the competition, in this case, the more waste is going to happen. Because all these people are going to invest funds. But only one person is going to

get the exclusive right. And the other people are just left high and dry.

So there's many examples where eliminating competition will actually increase the amount of social wealth contributed towards useful ends. But to the direct question of whether it reduces maximum forms, I don't know if that's known.

The studies in Alfie Kohn's article pointed to how competition reduces high-level performance. For example, complex cognitive tasks. Maximum performance, probably, one would need to define that pretty closely. And then one could do studies on it.

OK, so there was an interesting question about the understanding multiplication. So the understanding multiplication example I gave, where people could multiply 6 by 3 and get 18 but then couldn't come up with a word problem that used 6 by 3. Or they could, but the word problem was Johnny buys 6 apples on Monday. He buys 3 apples on Tuesday. So 6 times 3 is 18.

So that was, maybe, a bit unfair to ask students. Because writing a story draws on skills beyond mathematical understanding such as imagination and language. So it's true, it does draw on those skills.

But I don't think those are separate from mathematical understanding. If you can't explain the mathematics that you in you, you don't really understand it. When I was an undergraduate a friend of mine and I used to torment the math grad students.

It was sort of unfair. And we were really curious about math. We were fascinated by math.

And we wanted to know what people do in graduate school. And only later did I realize we were actually tormenting them. We weren't doing it intentionally.

We would ask them, OK, what are you working on? Sometimes we had classes with them or we'd see them in the math lounge. And they would say, oh, blah, blah, the theorem.

And we were undergraduates and young. And we didn't really know what the

theorem was. So we'd say, well, can you give us an example?

And that produced just deer in the headlights. Example? Example? That was completely foreign and not at all what they were thinking about. It was completely out of their space.

And later I actually realized that that was actually a very fair question. And if you wanted to test whether people understood what they were working on. And I found that things I can give examples on I understand. The things I can't, I don't understand.

Another example that is Feynman. He said, I have always found that I don't understand anything unless I can give a freshman lecture on it. Or equivalently, people asked him to give a lecture on something.

He said, no, I don't understand. I don't understand that well enough. I'll have to first work out a freshman lecture on it. Then I can explain it better.

And so there's famous lectures of his where he's explained anti particles and spin. And he finally got it to a level where he thinks it was actually suitable for a freshman, so first-year college students. So it's a brilliant lecture. If you search for the *Dirac Memorial Lectures* by Feynman you'll find that lecture there.

And it's fascinating. So it shows the level of how hard work it is to actually understand something of that level. And almost essential to that process is examples.

So examples, explaining, understanding, I think those are intrinsic to mathematical understanding. So it wasn't an unfair test. It was actually a test of high-level mathematical understanding.

One point was made, Swarthmore was not a women's college. Yeah, that's true. I mentioned that women's colleges were much more successful in producing women Ph.D. students in science.

And I listed Bryn Mawr and Smith. And then I listed Swarthmore, which was not correct. That was crosstalk between Bryn Mawr is and Swarthmore.

I grouped them all, Bryn Mawr, Haverford, and Swarthmore together. So Swarthmore is a coeducational college. And I meant Bryn Mawr and Smith.

And I was thinking of Wellesley as well. So Wellesley is an all-women's college, unless they've changed lately? No, OK. I mean every once in a while colleges think of changing. But they're still all women.

Now, people asked for references and further information about that. So I'll put a link on the website. But it's Barbara Whitten at the Colorado College physics department, she's done the most extensive studies on not just what makes for women being successful in science, but in general, what makes for students in say, physics majors.

She was the chair of the Colorado College physics department when I interviewed there. What makes for a successful undergraduate major program? So this is quite interesting for people interested in teaching.

Not just revising one course, but revising an entire department curriculum. So she's done cross-institutional studies of the culture of departments and what facets of the culture are responsible for students continuing on in science.

And what she's found is that the same features that help women continue in science help everybody. So I highly recommend her work. And I'll put a link to her web page on our course web page. Barbara Whitten. I think it's W-I-T-T-E-N. But it might be W-H-I-T-T-E-N, the Colorado College physics department.

OK, it's clear that I don't like No Child Left Behind. But would I do if I were the Secretary of Education in this country? Yeah, well, Hell would probably freeze over before that happened. There's a long vetting process before people become that. And you have to show your loyalty to pretty much every aspect of the current system before that happens, before you're appointed to such a post.

But if Hell froze over what would I do? I think one of the fundamental problems with education in America is the vast inequalities in funding, in resources. So the wealthy school districts have two, three, four times as much funds per student as the poor school districts.

And there's a good part of that. I mean, the disparity is bad. But there's a reason for the disparity. And the reason isn't all bad.

The reason is that America education is a local affair. It's controlled by local authorities. So the constitution reserves a bunch of powers for the federal government, printing money, making war, various things like that.

Then it says, OK, then the states can do a bunch of stuff like, for example, regulate voting. And then it says anything not explicitly given to the national or state governments is given to the people. Or in fact I think it says-- this is the 10th or 11th commandment-- especially devolution.

It says any powers not given to the federal government go to the state. If they're given to the state. And if not given to the state they go to the people.

And so education is in that category. It's nowhere mentioned in the constitution, education. So it's not given to the states. It's not given to the federal government.

So in America it's given to the local authorities. Now the problem is that different communities have different wealth bases. Because there's some very rich suburbs.

And for a while the cities were wealthy. But then people fled. All the wealthy people fled the cities in the 1950s during suburbanization. So the centers of cities became very poor.

So there's vast disparities in wealth there. And I think one thing that the federal government could do is actually just correct those. So there've been lawsuits along those lines for forcing state governments to try to correct that because there is some role for the states in education.

I'm not sure where that comes from in the constitution. But there are state boards of

education. And I think it's Vermont and New Jersey, there've been lawsuits in state courts to force the states to equalize funding across school districts. So somehow mitigating the differential in property-tax revenues. And I think the federal government could do that as well.

So those lawsuits are based on-- I'm pretty sure-- the 14th Amendment, equal protection of the laws. Now, there's no reason the federal government couldn't do that as well. So I would do that as step number one. No strings attached, here, let's just equalize the resources.

And then we can worry about what we're going to do after that. Whereas No Child Left Behind, what it does, it makes the resources actually, more unequal. Because it tests all the schools. And the schools that are going to do badly are the ones with less resources. And then they're going to get punished for doing badly. So I would take the opposite approach.

Is there a particular country's educational system that I particularly admire? That's a good question. Again, I think it's local. There's local educational experiments that I admire a lot and occasionally larger-scale ones.

A whole country, not so much. I mean, there's states in India, for example, for awhile Kerala-- I don't know if this is still true-- but had an incredibly high literacy rate, I think 98%, Which was much higher than anywhere else in India and matches literacy levels in the West.

And this has many benefits. So for example, one study about population is that population growth is slowed down the most by educating women. And Kerala actually, that 98% included women not just men.

So I think that's an educational system worth looking into. And places that I admire, there are local pockets. The free schools in the 1960s. There's a few places like that still in America.

There's the Sudbury Valley School. Maybe it's 50 miles west of here. It's in the

Sudbury Valley. And that's modeled on Summerhill, one of the earliest free schools in England.

So actually, it has its good and bad. So Summerhill, there's no required classes. And there's no required curriculum. And the students can go to class or not and can play outside.

So that would work really well. I think that works really well if all the teachers are really inspiring. Because then the students would be automatically drawn in to learn stuff. But if the teachers aren't very skilled then you have problems with that.

So I think it worked mixed there. But the potential is good and the freedom is really good. And it teaches people to be responsible. But it has its downsides.

So I have a personal experience with that. Which is when I was three. So I was born in England. And we lived there for a few years. And then we moved to New Jersey.

And I guess I was four maybe, my parents thought about sending me to England to go to Summerhill because this was 1973. So it was in the middle of lots of political change in America. Free schools were a big part of the cultural discussion. And my parents believed in those values, which I'm glad they did.

And they thought, OK, let's see about sending Sanjay to Summerhill. So we took a trip back to England. And they visited.

And the way they tell me what happened, was that everything was fine except then they were wandering around with the teacher on the tour. And they saw these marks on the door. And they said, what are those marks on the door?

Because they believed in the philosophy of letting children do what they want to do and follow their interests. But they said, oh, what are those marks on the door there? And they said, oh, that's Johnny. He likes to stand over there and throw knives at the door.

So then my parents thought, well, maybe that's just a little too unsupervised. Especially if the child is across the Atlantic from us. And it's not really easy to see

how things are going and intervene if things aren't going so well.

So they decided not to send me to Summerhill. But they sent me to progressive nursery schools locally as well. And I have good memories of those too.

So yeah, I would say there's a fundamental point in there, which is there's a difference between freedom and license. And so this is a distinction not often made. So license is the bad pole and freedom is the good. This is how I'm splitting the two parts.

So license is just do whatever you want. Take drugs. Be a prostitute. Do whatever you want. You're free.

Well, that's not really freedom. You're licensed. Whereas freedom-- in my mind-- has some intrinsic regulation on it. You're free.

You're a free creature. You have responsibility to use that freedom well. And license doesn't have any of that responsibility.

So I think when one is designing curricula like that you have to try to make the norm such that freedom is promoted and not license. Now, to some extent, you can't avoid a bit of license. Because, for example, the Summerhill teachers say that when students come from regular schools where they've been basically competing with each other, basically feeling beaten down, some of them come to Summerhill and just do nothing for a year.

They just sit outside and play on the swings and in the creek, just for a year. It takes them a year of detoxification before they are ready to go back into the classroom and learn things formally. So you could say that's a bit of license.

But maybe that's a bit of necessary license. Or maybe they're actually just discovering how to use freedom. And it takes them a year because they never had any practice with that. So I think it's important to keep those two pieces separate.

OK, so now there's so many questions. OK so there's two that I think are particularly

important to discuss. So there was a comment that one of the Alfie Kohn readings was off putting because he made comments about people with different political views than his and he seemed like a left-wing nut. And that, therefore, that reading shouldn't be assigned. So yeah, I agree that if you have quite a different political view than Alfie Kohn it can be a bit off putting.

But actually, I think that's a good thing. Now why is that? It's because it's fundamentally important to find views that challenge you and read them anyway. So as you probably guessed, most of my views are not mainstream. So I do that all the time whether I like it or not, just when I open the paper, or if I happen to watch television, which I actually don't hardly at all.

But if I open the newspaper or read things, just right next to my office there was a teaching magazine. I forget what is called. *Prism* maybe? I forget the name of the magazine.

But it's on the magazine display. And I just was walking by. And turned my head this way to read the title on the front cover.

And it said cash incentives are proving successful for promoting student learning. So this was against everything I believed in. So if I have the time I'll actually read the article.

But I'm surrounded by things I disagree with. And I think that's actually pretty healthy. So if you disagree with the article read it all the way through.

And the law professor Cass Sunstein from Chicago-- who's talked about as being a possible Supreme Court nominee by Obama-- he's written eloquently about the dangers of not doing that. Because it wasn't so possible 50 years ago. There was large-circulation newspapers and maybe two, three in each town. And people read those. There was a common discourse through that.

But now, everyone can get their own particular news on the internet. Right? You can get your own views from this small journal or from that particular newspaper or this person writing an article that you happen to agree with.

And the danger is of people just collecting into small little micro communities, where each community just agrees with itself and only reads things and discusses things that they agree with. And that's very unhealthy for democracy he points out, which I think is right. So I think it's very important to actually seek out things you disagree with.

And so if I happen to give you a reading that at first you disagreed with it's not such a bad thing. And it belongs, for sure, in an academic curriculum. Because that's one of the purposes of an academic curriculum. The word university comes from-- it has Uni in it, one. So the idea is it's one universe. All ideas are open discussion, even ones we disagree with.

OK, so let's see. OK, then the related one is, I find it off putting when I put my personal biases and opinions as absolute. For example, programming-- and this is related to the last point-- programming LaTeX may be easier and more convenient for me. But it's possible to develop familiarity with other software and systems that makes them close to equivalent, if not equivalent.

That may be true. Though I think there's fundamental reasons to wonder about it. Just because By not using a system such as LaTeX or Tex.

What's common about all of them is that you program them. And by not using a system like that, you give up the ability to program. And that is a huge loss.

You can see it, how much can computers do? The way computers are so powerful is because we program them. And the fundamental recipe for programming is-- at least when I teach it-- this-- So this is how the fundamental idea of programming I think.

So you do something and then you do it again. And when you're doing it again, you're like, oh, I just did this. Maybe I should write a program.

Nah, I'm too lazy. But then the third time it happens again. And you're like, OK, bloody hell, this time write a program.

OK, so basically the recipe is the third time you're about to do something, don't do it. Write a program to do it. So now you have a little mini program that you can reuse. Now it's a new module. And you can use that module to build still new programs. You can build a huge power abstraction.

So for example, in the figure-drawing program you can actually write programs that generate trees. And then you can write a five-line script. And you say, OK, feed that through my tree-generating program. And it'll make a tree that you can use in your figures, in your talks, or in your books. So I'll post a few examples of that. The input as five-line tree and the output PDF.

So the first time you write that program it takes longer than doing it graphically, no question. Which is why this second part happens. Because you do it the slightly hard way the first time. You don't realize the second time you're like, oh, there's something in common here.

[BUZZER SOUND]

But it's too late. I just have to do it the slightly hard way. The third time you think, OK, finally I'm going to do it with the program. So I think there are fundamental reasons to think that if you can program your documents you'll also be more efficient.

Now, that actually may end up not being true. I suspect it is. But it may not be.

But even if it isn't take it as not an absolute. But as a suggestion to try in your own work and in your own writing. And I don't mean it as an absolute. OK, so now there's 10 more questions. But I'm going to leave them for now. And if at the end we haven't used up all the time with questions I'll continue with some of those questions.