[SQUEAKING]

[RUSTLING]

[CLICKING]

JUSTIN REICH: Let's get right into it. There's a bunch that I want to try to catch up from yesterday. You've just turned in paper number one. But I'm a big fan of trying to have people do work, like do the daily work in the class, thinking towards what the major assignments are. So now, I have to tell you about paper number two.

For paper number two, you are going to identify a specific learning environment. You're going to identify the Physics Department at MIT, your middle school, your elementary school, your high school World Languages Department, an after school program you work with a library but something very specific, not like schools in general. A place. And you're going to reflect upon a particular education technology. And you are either going to recommend or not recommend that they adopt this particular technology.

So part of the argument that you'll read about in, hopefully, the first half of *Failure to Disrupt,* is that while we can get a general sense of the efficacy of different technologies-- we could say, this class of technologies seems to have better research evidence behind it than this class of technologies-- there's really nothing that anyone has ever invented, which is really every school or every department ought to be using X. All of those decisions have to do with particular times, particular places, particular people.

So what you'll have to do is identify some technology. Classify it like what genre is it from, or what is it like. What are its potential benefits? What are its affordances? What are its limitations? And then what is the characteristic of the place that you're recommending it to. And do the benefits, and needs, and characteristics of a place all line up, such that you recommend adoption? Or, do they not line up such that you don't recommend adoption?

It should be a memo directed to a particular stakeholder-- a department head, an assistant superintendent for curriculum and instruction, the library director, the President of the Boys and Girls Club, whatever it is. I think I had one student who was building a program for Ukrainian refugees last year. And he basically wrote a memo to himself, which was fine.

On pages 74 through 76, in *Failure to Disrupt* which-- at least in the hardcover-- I think it's the same in the paperback-- there's a section called What a Department Head Should Do, which is not exactly this assignment, but a pretty close worked example. So I think that specific example is about using intelligent tutors in math class. So you should pick something other than that specific example for you to use.

But you should think about doing things, like assessing the claims that the developers of this technology make, seeing what kind of research evidence there is around that, seeing under what context this seems to work or not, what kind of enabling conditions are required, whether or not those enabling conditions exist. We'll talk about all these kinds of things over the next few weeks. So you don't have to understand what you're going to do right now. But I you to have a sense of this assignment.

For some of you, you will pick a context that you can work with that you actually know a ton about. Or, like even if you didn't know something about it, you would be able to like, oh, the head of AeroAstro is a good colleague of mine. I'm going to just go ask him what he thinks about this. Or, like what capacity are and things like that.

There may be other things that you need to fabricate, which you would be allowed to fabricate. You just have to somewhere stipulate along the way that you're fabricating them. So I know.

I have to be like the characteristics of the world language teachers in my high school are this. And you might not actually know who the new staff are and things like that. But that would be OK.

There's pages written about what you're supposed to do in the syllabus. But does that give you a general sense of the target that you should be thinking about over the-- I don't even remember the exact dates, but it's roughly a month from now. Yeah, each assignment takes about a third of the class. So does that all seem good? Great. Anybody have any questions that they want to ask about that assignment?

OK, let's wrap up MOOCs. So last time we were talking about MOOCs made these three big bets. That they could provide new pathways into higher education for people with limited access. That they could reorganize, disrupt, unbundle higher education. They could create new structures across higher education. And then the one that I was most involved in is that they create a new data driven science of learning.

Maybe part of the second one, but maybe was clearly a bet for some actors, less so for nonprofits, more so for for-profits was that you could make a whole bunch of money doing this. That has not panned out as well as some people had hoped. So here's an announcement today that Accenture is purchasing Udacity. So Udacity was the company that was founded by Sebastian Thrun. Sebastian Thrun is one of the people who taught this Intro to AI class that made the whole MOOC phenomenon start.

Accenture is like a consulting firm, and they're going to use it to do AI training. So this is not like transforming all of education. This is doing pretty well-established executive education.

And there may be ways that you could do executive education better with the MOOC platform than you could with other pre-existing technologies, or strategies, or things like this. But like, this is not going to profoundly changed the way executive education unfolds. This is just like somebody who sells executive education, buying a potential provider of it.

In the notes here, it says that their best guess is that they-- a deal fell through with an asking price of about $80 million. And so nobody knows for sure, but they think that this deal was probably about that size. But Udacity took in $300 million of investment.

So I don't go to the Sloan School of Management like some of you do. But I'm pretty sure that if you take $300 million and sell a thing for $80 million, you didn't do it right. Or, at least your investors don't think so.

But I think that's, to me, it's a great indication of where this class of technologies have settled out, which is like $80 million, a lot of money. If any of you were offered $80 million for a business, you'd probably be like, yeah, that's pretty good. I'll take $80 million. That seems great.

But what it's accomplishing is like a very well established existing thing in the education system. Or, a way that I've phrased it in the book, which a colleague of mine really came up with, is that these technologies did not disrupt education systems. They were domesticated by education systems.

Education systems said, like you fit there. Like, you, little company, you would be pretty good at doing executive education. Why you don't you do that?

That is not at all what Sebastian Thrun was envisioning when he said that there might be only 50 educational institutions in higher education in the world. But to me, this is very representative of how I think education technology often works. We very rarely build things that are totally transformative. And we can often build things that are useful in pretty specific contexts.

I and lots of other people had really hoped that there would be very new kinds of science that would be possible. So we had never really, in higher education, had a system where you just had, all of a sudden, millions and millions of people doing online learning and all of that was being recorded. So when I got hired to help build the research infrastructure for HarvardX and MITx and EdX, one of the most exciting things was like, all of these people are signing up. And they're all clicking. And we're recording everything.

You might think of all of the things that you did in school. Probably even better, as an example, like think about all the things that I did in school. So I filled out zillions of worksheets. I typed all kinds of papers. All that stuff just ended up in my mom's attic and was eventually thrown away. The whole records of my learning were lost.

But young people today have their records of learning stored in all of these online platforms. If you saw what millions of learners were doing in really granular, detailed ways over days, or months, or years, shouldn't you be able to figure out all kinds of exciting things about the science of learning, about like what are the most effective teaching techniques, how do people learn best? All kinds of things that might be helpless.

And it proved to be much, much harder than people expected. I would say, the core reason why it proved to be really hard is that you can have terabytes of data about what people click, and still not really know what's going on in their heads. What people click on a screen or what they add as an answer to a problem doesn't necessarily tell you all that much about the cognition that they went through to get there. It doesn't tell you a whole lot about which parts of the instruction that they receive to that point helped them do that.

For years, there was a whole class of papers that just correlated everything to everything else. How many times do you click? How many times did you log in? How many units did you do? How far apart they were? All these kinds of things.

And basically, like there was a whole series of papers that were all published that were all along the lines of people who do more stuff do better than people who do less stuff. People who clicked more often in the systems, people who watched all the videos, did better on the problems. People who did all the problems were more likely to pass the course. People who logged in more time, people who spent more hours were more likely to pass the course. None of that is interesting. You didn't need a $60 million research enterprise to figure out that doing more stuff helps people learn.

There are a few things that we did that-- and I'll talk about them more as the semester goes on-- that tried to go beyond that. There were a bunch of us who were really interested in this idea that like-- a bunch of people have done research that suggests that the attitudes that you bring to a learning experience really matter for your success in that learning experience. And of you ever heard of stereotype threat?

So stereotype threat is this idea that if we trigger stereotypes that people have as they enter a learning environment or as they're in a learning environment, those stereotypes can negatively impact them. So if you ask people to describe their gender before a math test, then people who identify as girls are more likely to do less well. You can do the same thing in different racial configurations and other kinds of things like that.

And the way that you can inoculate people, in theory, against some of these kinds of things is by emphasizing how they belong. Is by saying, like you belong in here. Like, you have a space, you deserve to be here.

And so you could imagine that if people go into a learning environment, and they're like, I'm not sure if this is for me. Then you're paying attention to not feeling like this is for me. And you're not paying attention to the learning. And then a test comes along.

And you don't do as well on that test. And then that makes you feel like you belong even less. And then you're feeling more unbelonging. And then you don't do as well. And you get a negative cycle.

You could imagine the opposite, where you feel like, oh, I definitely belong in this learning environment. This is going to be a good growth experience for me. And then you are focused on learning. And then you do better. And that makes you feel like you belong, and on and on.

So we were really interested in these entry points. And basically, every class at Harvard and MIT offered had a little pre-course survey at the beg-- have any of you ever taken a class that has a little survey at the beginning of it for your MOOCs? If you did it for Harvard or MIT, I probably wrote it, especially if you did it a few years ago.

And so we started randomly assigning people these little interventions. Like, you'd answer a bunch of questions about what you know about the topic. And then we'd say things like, write a letter to a future student-- one was a values affirmation. Pick from this list which of these values are really important to you.

And they-- I don't know. They could be like loyalty, personal growth, family, all kinds of things. Write a short letter to yourself about why taking this class aligns with those values. So asking people to just write for a few minutes about why-- we do other things about belonging, right? Write a short letter to a future student in this class about why they should feel like they belong. Things like that.

And our hope was is that it would trigger this positive cascade at the beginning of the class. You feel like you belong more. You feel like you value it more. You do better. You pay attention more, you do better, you learn more, all those kinds of things.

We started by trying these in just a couple of classes. And even if we were picking a couple of classes, we were still doing some of the largest experiments that had ever been conducted in higher education. We could pick a couple of classes that might have 10,000 people that were actively participating in it, and doing our things, and things like that. Kind of a lot of folks.

So here are four things that we tried. One was plan making, having people write down exactly how they plan to complete the class. Like, when they were going to do it, who was going to help them, what they were going to do when they get stuck? Those kinds of things.

This value relevance things that you just described. And then mental contrasting with implementation impatient intentions is basically like, what are the kinds of things that might make you stuck? And how would you get unstuck when you encounter these things?

When we did them in one or two classes at a time, they worked pretty well. So I don't know how familiar you are with statistics. But the beta parameters are the one you look at. So this plan making things people were four percentage points more likely to finish the class if they got the intervention than they didn't.

That's huge. If you ask you ask people to do something for five minutes at the beginning of the class and they're 4% more likely to finish it-- just like the cost-benefit of that is off the charts. That's fabulous.

This one was getting people to do more activities, getting people to persist longer, getting people to complete better, all these kinds of things. And some of these studies were huge-- 5,000 people, 3,000 people, 2000 people. That's pretty good.

We then were like, we were pretty excited about ourselves. We were like, we've come up with some stuff that doesn't cost anything and really helps learners. Let's go ahead and take these things and use them in all of the classes. Let's let Harvard and MIT let us test things in every class.

And it is not uncommon in educational research, that if something works in a little space, that when you try it at much bigger scales, it doesn't work. That is a very frustrating finding, but also a very common finding. And that is exactly what happened to us.

So we took these things which, again, would have been considered like huge studies in education. Randomly assigning 4,000 people to a treatment or not is enormous. And we did it with a quarter of a million people, like a lot of learners. And basically, everything that we had tried and wrote a bunch of papers that said, hey, these are pretty good ideas-- we had to be like, actually, they don't really work that well.

And part of the problem was they appeared to work in some classes, but not others. And we couldn't make any sense of why. Part of that is that it's hard for us to know a whole lot-- if we did it in about 250 classes. And it's hard to know the difference between those different kinds of things.

But we listed characteristics of all the classes. And we put them into big AI models to try to figure out why. And all these other kind-- I mean, you can read the paper.

But it was an enormous effort. And at the end of it, a thing that we had lots of people in there, but we weren't able to identify things that worked particularly well. And this was pretty consistent across this enterprise. In fact, to my knowledge, there's virtually no one who's doing research on Harvard or MIT-- HarvardX or MITx classes anymore. And so this was the third of these big bets.

There are people like Peter Norvig and who's a woman, Daphne Koller, who formed Coursera, who thought that data-driven education would be very similar to data-driven medicine. Like, just like the Human Genome Project revolutionized a data-driven form of medicine, that Coursera, EdX could revolutionize a data driven form of the science of learning.

And we knew a lot about what people clicked, but we never really got much more data about what was going on inside people's heads. The other huge issue is that if you really want to do educational research, that studies how to help people learn better, you need variation in the course that's deeper than what we were attempting. You need to be able to do more than just change a little thing at the beginning of the course.

You have to be like, well, here's one good way of teaching a class. Here's another good way of teaching the class. Let's try both of them. Well, it turns out that it was very difficult to go to faculty and be like, will you make two versions of this course, so that we can test some of these different ideas in them-- because people had barely enough time and resources to make one version of the course, and so forth.

So like the other two big bets of MOOCs, they, for the most part didn't pan out. And I think, if you go back 10 years from now and read the op-eds that David Brooks and Thomas Friedman were writing in *The New York Times* about the totally transformative impact of online education, people would be pretty surprised, 10 years later, to find out that it's good for things like executive education or helping people earn a second master's degree, which are not bad things to do. But again, they're smaller components of it.

I've thought a lot over the last couple of years about, OK, so if we're not going to totally reform the educational system with independent, self-paced online learning, what else might we do? Well, so for instance, I've told you that already affluent, already educated people are reasonably likely to persist in online courses. Well, there are all kinds of already affluent, already educated people who work in the public interest. There are people who are teachers. There are people who work in public health. There are people who work in nurses.

Lots of them work in contexts where they don't have a lot of learning after their college degree or their advanced degree. So what if we created online courses that a good fraction of people would be able to persist in and finish? That would be able to help them.

There was one course that we built called Launching Innovation in schools, which relates to the stuff in Iterate that you read a couple classes ago. And in our course, we make all of our-- not everybody do this-- we make all of our courses openly licensed. So we make it so that it's Creative Commons. Anybody can take our things and do anything with them.

There were some folks in Ukraine, before the war, who had translated our courses into Ukrainian and put them on a Ukrainian platform. And for a while, at the beginning of the war-- I don't know if this is still true-- teachers still had to get recertified, and do training, and things like that. So some enormous fraction of the Ukrainian teaching force had at least signed up and plausibly taken one of these courses and things like that. So for us, it was of a proof of concept that people can benefit from some of these kinds of things.

With Mariana's advisor, José, we got really interested in what if the thing you want is not really big MOOC providers, but very small local MOOC providers. So there's an organization called Bedrock in Jordan run by the Queen Rania Foundation that makes MOOCs in Arabic for people in the Arabic world. There are lots of providers that offer courses in the local language of their environment that are tailored to the particular environments that they're in.

And these tables are unreadable, except if you go in them and look at them. But there's evidence that you could actually do a better job getting people from more diverse educational backgrounds if you offer them in local languages, with local providers with the topic area and content areas that would be interesting to people in those local places. So what we needed was not like giant, global, elite-driven online learning, but maybe another pathway with lots of distributed local online learning that was particularly tailored to people's cultural interests, and labor markets, and civic spheres, and needs, and things like that.

I mean, I always try to remain open to the idea that any of these technologies could have new people that come along and refresh the ideas around them. But we should probably think of those claims with a pretty high bar. If someone comes along, and says, they have a new AI-powered MOOC platform or something like that-- now, you could be like, well, let me tell you what the research suggests about the original MOOC platform, what some of the limitations were, what it accomplished, why it tackled some big problems that turned out to be really hard-- and then what is it that a new effort would be able to build on top of that.

Those are some of the things I want to tell you about MOOCs. What other things struck you about them? Or, what questions did you have? Or, what have we discussed in the last few classes that fit or don't fit with your experiences?

AUDIENCE: I mean, I guess just a general question is like, what is your real motivation for higher educational institutions to want MOOCs to exist, considering that their entire business is based off of them, not like--

JUSTIN REICH: It's weird right? [LAUGHS] Yeah, like people got super enthusiastic for a long time about digitizing faculty labor. So what were some of the things that people would have said, at the time?

In 2013, people would have said something along the lines of-- particularly for the last 40 or 50 years, but maybe for 100-plus years, there's a class of universities that brags every year about how many students they don't serve. Around this time every year, Stanford and MIT and Harvard will publish statistics about how many applicants they rejected.

But one of the things that they could do with MOOCs is start bragging about how many people they served. For the faculty, who are especially early on, who got millions of people to sign up for their courses, it was exhilarating. It was incredibly exciting to be able to say-- I mean, Naman Aggarwal used to say, if I taught 6.11 at MIT for the next 40 years, I still couldn't have as many students who showed up in the first round of this class that I offered, and things like that. So that was exciting.

I have a hunch that when people were afraid that this might profoundly changed the education landscape, that elite universities wanted to be in front of it, rather than behind it. Like, as soon as there was some commercial offerings that were available, there were folks who said, man, we really ought to have a nonprofit alternative. We ought to have universities that are involved in this.

I mean, another really important structural factor is that university revenue sources are constantly under threat. And their costs are constantly going up. So health care costs are constantly going up. Technology costs are constantly going up.

And if you're a state university, like across the United States, we've been dramatically reducing the amount that the taxpaying public support schools and asking students to pay more tuition, and so forth-- or, a higher percentage of their tuition. And so a bunch of folks thought they could make money doing it-- not make money, in the sense of putting their pocket-- but make money doing that.

So those are some of the kinds of reasons that people got really excited about it. But yeah, in retrospect, in some ways, you're like, why-- I mean, at the time, there were definitely plenty of people who were like, you want to take this thing that we sell to people for $80,000 a year and give them to them for free? Like, what kind of plan is that? Or, for 35 bucks or other kinds of things like that.

AUDIENCE: One thing that I was thinking about, with respect to presenting books with like helping underserved communities and stuff is like the issue of space. Because to me, I feel like having been in like a pretty underserved high school and stuff-- I was like, OK, well, even like in a position of higher education, space is a very big issue for a lot of these spaces.

Where it's like, you simply can't just sit at home. And even if you have access to a laptop or something to do that. And it was like, I just wanted to know if-- I mean, this might kind of also just connect to the larger social aspect of it-- but I was wondering if this even came up when they were talking about the accessibility of these systems.

JUSTIN REICH: I mean, I used to joke that something like anyone, even the poorest peasant in the most remote African village, who has high-speed internet and a basic understanding of matrix algebra, can take the Introduction Aeronautics class. And I was like, yeah, there actually are not that many peasants, who meet both of those criteria.

[LAUGHTER]

But it was always the case. There was a very famous case of-- there was the article in *The New York Times* about him was called "The Boy Genius of Ulan Bator." So there was a student who was in Mongolia, who got a perfect score on the first MITx class and was admitted to MIT. And this was taken as proof that, like anybody, anywhere in the world can get access to our courses. And we're going to be able to find the best high school students and bring them to MIT.

Well, there were some more details to the story. One is, the principal of that school in Mongolia is, as I understood, at the time, the only person from Mongolia to have graduated from MIT. So there was kind of a connection there.

Second, there was an advanced physics class that was offered that used the material. But there was a postdoc, who I think was at Stanford or some elite school in California, who went and studied with these kids for a bunch of months.

So one thing you could say is like, oh, we just need to get MOOCs into every school. And then we'll help people find their way to MIT. The other thing you can say is like, we just need MIT grads being the principal of every school.

[LAUGHTER]

And then we can get people coming to MIT. But this kid, his name was Battushig. And he did a bunch of education classes at MIT. He was a remarkable kid. He used to watch two videos at the same time when he was doing these classes. It doesn't make any sense, but there's a great news article that shows his little setup of him watching two videos at the same time. I mean, he's clearly a smart guy.

But it was really important to the narrative of MOOCs that, look-- look at, look at how far into the periphery that we've reached to bring people into the core. And so folks like me, who are writing papers, are like, that is neat. That is a true story. Battushig is an awesome kid that is not representative of the broader system that we've built here.

And yeah, it was interesting. People really wanted these things to be democratizing education. But then, when it was pretty obvious they weren't, they were still like, yeah, well, OK. We'll just use them anyway.

I know. I helped support-- I did an evaluation of the Supply Chain Management program, which was one of the first programs that said, do half the program online. So you have to take and pass proctored tests in four or five online classes. And then we'll give you half a degree credit. And you come to campus and finish the other half of the degree.

And there are a lot of good things about it, actually. So one is supply chain management is a relatively new field. And so there aren't a lot of universities around the world that offer it. And MIT is pretty good at it. So this was a good way of having more people be able to do it.

It's a relatively small program. They don't have a ton of faculty. So in theory, you could have twice as many people come through campus if they do half the stuff online and half the stuff here.

And there were, actually, some really cool findings where the folks who-- the way they did it is they kept an in-person cohort and added an online cohort that showed up with in-person cohort in January. And we did some surveys about how both groups felt, in terms of their connection to MIT. And they both felt really strongly connected to MIT.

Actually, in sort of funny ways, like on campus people were like, we've been here all year. Like, this is our place. And the online people were like, we've been taking these classes together for three years. Like, this is our place. So they both felt really connected in interesting kind of ways.

The grades of the online folks were actually slightly better at the end of the first cohort. Although, who knows if that would have persisted into time. But the only people who persisted through the online courses were people who already had the jobs in logistics industries were getting their second degree, were already affluent. They were disproportionately guys.

There's a whole line of research that really focuses on people's ability to conduct self-regulated learning, people's ability to persist through difficulty, and things like that. And so you talk to learners. And they would talk about how they took their lunch breaks and they studied, how they took weekends and studied, how they stayed up late at night and they studied. And especially if you think about it through an individual psychological perspective, you're like, yeah, those are all great qualities.

Another thing we realized, though, is like if you're studying in the evenings, you're probably shirking family responsibilities. And in lots of cultures across the world, it is way easier for guys to shirk family responsibilities than it is for women to shirk family responsibilities. So in some ways, self-regulated learning was the same thing as shirking family responsibility.

Like a thing that you'd study from a psychological perspective is self-regulated learning would be shirking family responsibilities, from a sociological point of view. And so, again, just giving us more ways to think about, as we create learning environments, who will benefit from them? What are the enabling conditions to help lots of people from lots of different kinds of backgrounds and places in society be able to benefit from them? Things like that.

AUDIENCE: I think something that stood out to me was the business model of the MOOCs. I think I don't really understand it because, I think, for me, as someone who went to international school in Africa-- and I would say, I was what, maybe like top five, like in my country or something. And pretty big, like in Africa.

Like I'd never heard of any MIT or Harvard course, like in my life. I'd probably say, none of my teachers have ever heard of it. And I think it made me wonder, who exactly they're targeting.

Because I don't think it's necessarily young high schoolers, like trying to get into college. Because what I did realize when I came to MIT, and when I Googled like how to do linear algebra, or all these things is then I would see MIT courses, and MIT OpenCourseWare, and all these things pop up on YouTube. But then, back in high school, and I didn't know what linear algebra is--

JUSTIN REICH: If you don't know what linear algebra was, how are you going to search for a linear algebra course---

AUDIENCE: Yeah, it was something that came to my mind--

JUSTIN REICH: Yeah, yeah. No, that's a terrific example. I mean, the business model-- I mean Daphne Koller, and I think, in one of her first talks, refers to it as a blue ocean business model, which is, basically, the potential addressable market is like six billion people in the world or something. Anybody who's got an internet connection, if you can sell $35 certificates a couple of times to six billion people over and over again, you can make a lot of money doing that.

And there were efforts to try to create institutional connections. So CS50, who's Harvard's computer science class, has a whole program to help high schools to adopt the online CS50 materials in their in-person instruction. So there's some fraction that you, hanging out in Africa, would have encountered this course and just decided to take it. There's some sense that your school might have made-- connected with one of these formal institutions.

There was another great story of the guy who founded stripe was from St. Louis. And was like, I want to live in St. Louis. And I can't hire any developers in St. Louis. There aren't enough developers. I'm pretty sure it was St Louis. I might have the town wrong.

So when MOOCs came out, he was like, oh, let's offer CS50 in St. Louis. And we'll start like building infrastructure for this. And they started some pilot program. And it completely filled the library. There's hundreds of people, who with a little additional support-- so they ended up they ended up like creating a community space for it.

So you use the online materials. That was-- I think there were models like that to try to bridge the gap that you're describing. That it's not realistic to just have kids encounter these classes and decided to get excited about them, and things like that.

Still, almost all of those intermediate bridging layers require human capital. And humans are super expensive. And then you erase the kind of financial advantages that the MOOCs were promoting in the beginning.

Lots of online programs have found this. It's pretty cheap to offer online classes, but a lot of times people just drop out of them. If you want them to not drop out of them, you have to hire coaches, and advisors, and assistant instructors, and things like that. And then you've just-- you brought back all the costs that you got rid of from teaching.

AUDIENCE: Is there like a statistic on how often state universities create MOOCs versus these Ivy-esque schools? Because the thought occurs to me that maybe the reason why it doesn't matter if Harvard or MIT or Stanford puts out a MOOC is because you're not coming to Harvard or MIT or Stanford just for the information.

JUSTIN REICH: Yeah.

AUDIENCE: Because, obviously, what's associated with that is kind of like this title and this class stratification thing that isn't accessible through a MOOC. So it doesn't matter if the entire world has access to a course that's meant for learning-- because part of what you pay for and part of the real target audience of these universities is people who want the title associated.

JUSTIN REICH: Well, there was an economist at Stanford who wrote a cool paper that says, the way you have to understand elite education funding models is that they roughly offer their education for free, in the hopes of having a very small percentage of people pay very large amounts of money for their education later. Basically, we subsidize people's tuition in all kinds of ways. Even if your tuition feels really high, your tuition is subsidized far beyond what it actually costs to educate you. And then, hopefully, 1% of you will give tens of millions of dollars back to MIT later. And so this person was trying to think about like given that's actually how elite universities are funded, what effect will MOOCs have on those kinds of relationships?

But there were plenty of public institutions. One reason that public institutions got really excited about it is their job is to serve as many people in the state as possible. And if you're in a geographically large state, like Virginia, and you're the University of Virginia in the middle of it, like it's pretty hard to help people in the Tidewater, and in the southwest area, and in the DC area, and other things like that. So Michigan made big investments. Texas made big investments.

There were lots of flagship public schools. Probably the most distinctive one, maybe not in MOOCs, but just in online learning, generally, is Arizona State University, which has really transformed itself through online learning into a global institution-- which they really see as mission-driven. Like how do we just have as many people as possible in Arizona beyond Arizona get access to the learning opportunities we create? And there's something very noble that I find about that.

AUDIENCE: I wanted to follow up on your first question about the business model. How have for-profit universities reacted to MOOCs, since their entire model is trying to serve as many underserved people as possible and just like charging them a lot? And the fact is that a lot of them are also online on the--

JUSTIN REICH: Yeah. Yeah.

AUDIENCE: Like the University of Phoenix, I think.

JUSTIN REICH: Yeah, University of Phoenix, Kaplan, Southern New Hampshire University, Western Governors University. I mean, I think there are some Southern New Hampshire University would have really welcomed--

In some way, some of their reactions were like, hey team, this is not new. This is exactly what we've been doing for decades. So a weird thing was that there was a status flip in online learning.

In 2010, online learning was a very low-status activity. It would have been primarily conducted at community colleges, for-profit colleges, state colleges. And overnight, instantly, Stanford, MIT, and Harvard made it an elite activity. They instantly-- there's actually all kinds of sociological theory about this, where the middle class people have to avoid the activities of lower class people and pursue the activities of upper class people. And lower class people pursue the activity of upper class people.

But upper class people can actually pursue the activities of lower class people because their status is safe. Like, every once in a while, there are trends come along of people who dress like trash or other kinds of adopting lower class activities. So there's some sociological theory that is behind some of that. But it was one of the things that was striking about that moment.

So a bunch of these universities were like, give me a break. We've been doing this forever. I gave a talk at Oakland University, which is kind of a community college in Michigan. And they were like, they'd be like, why are you using video? Like text is so much better. We've been doing this for years.

Like, lots of people can't download the video. Like bandwidth is not that good. And there's not really a benefit to watching someone say something versus reading what they would say. Like, what are you all doing? And be like, you might have a point there.

[LAUGHTER]

Because they were doing something exciting. But on the other hand, if you're really fired up about online learning, and Harvard, and MIT, and Stanford, and Johns Hopkins, and Michigan are like, no, online learning is cool now-- there's ways that you can use that to raise your status, to legitimize your activities, and other things like that. So existing players.

And they weren't really pursuing similar kinds of markets, for the most part. I mean, there are a handful of MOOC efforts that tried to help people earn bachelor's degrees. And they were mostly totally unsuccessful. And there weren't even really that many of them that were tried, which that is kind of like the sweet spot of most for-profit colleges-- which in many respects, there's a lot of evidence that they're just a disaster for-- a lot of people don't finish. People finish with a lot of debt.

Tressie McMillan Cottom wrote a book called *Lower Ed,* where she described them as a negative social insurance program, where on average, people are worse after finding their ways into them than they were beforehand. Her book, *Lower Ed* is pretty fabulous. All right.

Let's make sure that we get a chance to talk a little bit about part two, which is Algorithm-Guided Learning At Scale. So it sounds like a bunch of you-- we're heading into new territory for me, which is like-- well, raise your hand if in your K-12 experience, you did something that you think was algorithm-guided learning at scale. Like you sat in front of a thing-- OK.

Like this, by far, the highest percentage that I've had in this class, thus far. So I don't know, five years ago, like a handful of people wouldn't have done it or had done a little bit as a curiosity. But like, clearly, if you all know what IXL is and things like that, this is becoming a much more mainstream activity in people's classes.

What was your sense of them? So Dana's sense was that they were kind of pointless. And she could just have her mom do them for her.

[LAUGHTER]

What were other people's sentiments about them? Emily.

AUDIENCE: Well, for me, like in high school, we used this thing called Moonbeam, where it was like, you would take an assessment and it would kind of like rank you like where you're reading and your vocab skills are at. And then you log in every week to do it, and learn, and progress, I guess. And I thought it was useful for us because, even though we had like regular classes or honors classes for English, like within that class, like everybody's vocab like--

JUSTIN REICH: It was different.

AUDIENCE: It varied a lot. And it was very hard for the teachers to figure out what kind of vocab to teach, what materials to provide for us because everybody had different things.

JUSTIN REICH: Yeah.

AUDIENCE: And like a lot of times, we would just sit in class, like, I already know this word.

JUSTIN REICH: Yeah, this is dumb.

AUDIENCE: And like, you just stop paying attention. But then other kids are like, well, I have never heard of this word. I need to learn it.

JUSTIN REICH: Yeah. Yeah.

AUDIENCE: For us it was cool. But then, one of my friend, she assessed it. And she started off in the highest level ranking. And then after she finished, they just bumped her back down to level one. So then she just went back to learning like blue, green in like high school and sophomore year. So it was like--

JUSTIN REICH: That sounds like a flawed system.

AUDIENCE: Yeah.

JUSTIN REICH: I will tell you, though, when I was in the fourth grade, we had a similar version of that. They were called SRI reading cards. It was like a file box, and it was a bunch of short stories or nonfiction passages that were arranged in order of difficulty.

And you would just go and read one and answer a bunch of questions about it. And if you got them all right, you'd go on to the next one or a couple later. And if you got them less, well, then you went back to earlier ones, or your teacher helped you, or something like that. So I mean, it's something that will come up, but this notion that like, oh, what would it look like to figure out what kinds of learning experiences people need, in that moment, and try to meet that need, instead of teaching everybody the same thing at the same time, has been compelling for a long time. It sounds like it was compelling for you, at least until the system freaked out and made you learn kindergarten words again.

AUDIENCE: Yeah, we had something that like reading as well. Well, I think one of the issues was it was not nearly as consistent because I mean, it was meant to be done once a week or twice a week, like a lot of the examples we saw in class. But it'd be like, oh, like whenever the teacher didn't want to deal with us to kind of bring in the cards. It's like, OK, do this. So it was so inconsistent. That I was like, OK, well, I don't exactly know if I'm improving or I'm staying stagnant because I haven't seen this program for two weeks now.

JUSTIN REICH: Good, you've said two things there that I really want you to hang on to. One is you said something which Larry Cuban would have said about television things or things like that, which is that the designers of this program have a vision, but the teachers have a different set of needs. So the teachers are like, I need to do some grading today or I don't feel well, we're going to do this thing-- which would have been the exact same thing as rolling into television and putting on a movie for people to watch.

And also, that the systems have some kind of pedagogical model behind them and their effectiveness may have to do with how well that pedagogical model is implemented. So if the system is designed to be used with some consistency, twice a week in six week chunks or something like that-- and you don't use it with that program design in mind-- it might not accomplish what you wanted to do. So it's not just a matter of like downloading the software onto kids' computers. It's a matter of getting whole systems to implement them.

We're going to look at some research I'll show you on Monday. I don't know if I'll make you read it-- but I'll just summarize it for you-- about some of these intelligent tutors that are really focused on letting people work on problems that are challenging for them, even if it's from material that is from earlier in the year or previous years. And that system only works if teachers actually let their students do that. If teachers force their students along, against the will of the system, then the system doesn't do what it's supposed to do.

AUDIENCE: I think-- I guess to elaborate a little bit, why on like my experience was the way it was, was like not only were teachers like in your experience, just like doing it randomly, they weren't incorporating it into their curriculum. They were just like slapping it on top of it. And when students are already overwhelmed with after school activities and things like that, it then like-- and it was like more of a math-based thing than English, where you see some of the benefits early on. So it was just kind of thrown in there, but not incorporated in the curriculum. And then it's just like, essentially, became a low priority--

JUSTIN REICH: Good--

AUDIENCE: And like for a lot of people.

JUSTIN REICH: So if a system like depends on some hybridity, if it depends on some things that are happening in class and some things are happening online-- like if those two pieces are not fitting together, it's not going to accomplish what the system wants to accomplish. All right. I'll give you a funny little piece, a little personal piece that is behind some of the technology.

I explain some of this a little bit, but my father has more or less done one cool thing in his life, which was to get a fake person into Princeton. He and his frat buddies invented a person named J David Osnat or Joe D Osnat or Joe Does Not. And they found a friend of theirs to take the SAT for him. They found some friends who had a frat house in Michigan to make up a fake transcript. They got one of them to go, and do an interview, and things like that. And they got this fake guy into Princeton.

And they eventually had to admit it. And at some point, somebody was taking one of them to the admissions office to go explain to the admissions officer that they had gotten a fake person into Princeton. And this guy started asking them a whole bunch of questions about how they took the SAT. And it turned out this guy worked for educational testing services, which was also in Princeton, New Jersey, and was trying to figure out some of the test security things that were going on there.

So as I mentioned last time, one of the ways that you can make tests more secure is that you can make it so that tests are of equal difficulty, but they use different questions. So the students in Boston are not taking the exact same test that students in Hawaii will take six hours later, or students in other parts of the world, or things like that. In order to be able to do that, you have to be able to create a mathematical representation for any given item of how difficult that item is.

What people basically decided to do to solve that is to model the difficulty of items as logistic functions. So on the x-axis, you have this thing, which is a proficiency score. Roughly kind of how hard in any domain this would be. And then the probability of a correct answer. So these are three different possible distributions of items. So for instance, which of these items would be the most difficult for individuals with proficiency score of 1.

AUDIENCE: The blue.

JUSTIN REICH: So people on the blue have almost 100% probability of getting this one correct.

AUDIENCE: Oh, I was wondering.

JUSTIN REICH: So it will be the green one. So this is the probability answer. So for this particular item, people with proficiency of 1 are about 50% likely to get it right. These are the people who are about 90% to get it right, almost exactly likely to get it right. So that seems like a useful thing to know about an item, right? Now you can figure out, like, oh, let's give them the blue item first, and then the red item, and then the green item, or something like that.

Not only that, but if you model it this way, you can also figure out how discriminating an item is, which is how likely is it that people around a given proficiency are likely to get it wrong or not get it wrong? Like, how tightly clustered are the answers versus be or how spread out are the answers going to be?

So around 1, you would imagine for this one, that a whole bunch of people with scores slightly less than 1 would be less likely to write. And then more likely to get it right. Whereas, around here, because the lines are more horizontal there, just about everybody who gets those items are going to be right. So it's going to give you that much information about how well people do.

Another way that you could do this is draw a distribution of where you think a group of learners would be. So this is like the various skill levels in the class and the distribution of probabilities of people getting it right. And you can see that the item that traverse through the heart of that group is going to be the one that's best at efficiently measuring the proficiency of that group.

You don't have to totally understand all the math or all the ideas about this. Probably, like the intuition that you need to develop is in the 1980s, a bunch of people came up with a pretty good statistical toolkit for figuring out how difficult an item was. The first thing that they did with it was make different kinds of tests for test security purposes.

But almost the next thing they did with it was start developing systems that use computers to evaluate people's performance on an item, and then figure out what is the next good item to give them in a sequence. And all the things that you're describing IXL, Khan Academy, all other things like that, they may not use this exact statistical toolkit, but they all use something that's similar to that.

I mean, part of the reason why in the book that I take a couple of pages to describe item response theory to people is, again, to try to give the sense it's not magic. It's not like some impossibly difficult thing that computers and scientists on the very cutting edge of mathematics have figured out. This is a pretty well-established set of tools that we've studied for a long time.

If people come up with new AI-powered intelligent tutors, we should absolutely be able to ask the question like, well, how are they really different from the intelligent tutors that we've had for decades, in various formats? How different are they from the box of SRI reading cards that I had when I was in the fourth grade? And there may be some ways that they're different, in which case, we would expect much better outcomes. There may be some ways that they're quite similar, in which case, we might not expect that many differences. But the heart of the reason why people wanted these kinds of tools to exist was personalization. That a goal that you can get a lot of people around is the idea that wouldn't it be great if every learner could have an experience that's tailored to their own personal needs, and interests, and experiences, and things like that?

I noticed, I don't know, around 2008, 2009, 2010 that lots of people in education got interested in personalization. A thing that was weird to me is that there were people who were interested in personalization, who disagreed about everything else. So there would be people who are really into school choice, and traditional instruction, and conservative curriculum values, who typically were more associated with people on the political right, though not always in America, who got really interested in personalization. There were also people who were educational progressives, who were really interested in alternate, project-based school kinds of models. They also were talking about personalization.

And I thought to myself, OK. If these groups who don't agree about anything are all using the word personalization, they can't possibly mean the same thing, because they have really different values. And so they probably don't agree about this either.

Oh, this was a slide that my colleague Dan Meyer put together of this is some technology from the 1970s. Right at the dawn of personal computers, where we were trying to give kids math problems, evaluate them, give them harder problems. This is a slide from 2012.

But the thing that you can see is there's 40 years between these pictures. And they are strikingly similar in their setup, in their outfit. Trying to personalize education with computers is one of the oldest enterprises in educational computing. It is one of the main things that we've been trying to do for 40 or 50 years.

If there is any single paper that got people extremely excited about this, it was called "The 2 Sigma Problem-- The Search for Methods of Group Instruction as Effective as One-to-One Tutoring," where this guy Benjamin-- any of you ever heard of Bloom's Taxonomy? It's this little pyramid that has different kinds of learning activities, instructional activities you could do. It turns out that Benjamin Bloom did more than one thing in his life. He didn't just make this taxonomy, but he other kinds of studies.

He didn't actually do these studies. He was reporting on some doctoral students of his that were studying tutoring. And in these tutoring studies that they did, you just get astronomically good results. They said that they could get results two standard deviations better what you'd typically find. That's the 2 sigma problem.

A two standard deviation improvement in education is impossibly good. Most of the things that we do get a tenth of a standard deviation, or a hundredth of a standard deviation improvement, or something like that. We usually get really small gains, but tutoring works really well. I mean, to some extent, you could be like, I'm pretty sure medieval lords knew that tutoring works pretty well.

[LAUGHTER]

The reason why we don't do it is it's enormously expensive. But what if, instead of medieval lords hiring governesses to tutor their students, what if computers could do that? What if computers, which are relatively inexpensive, could do this kind of tutoring? So this has been a dream. This was Daphne Coller's dream, Saul Cotton's dream, lots of other people's dream as they were imagining what's possible here.

Around 2010, there were probably two different groups of people, who made personalized learning central to their ideas and their philosophies. One group of people were really interested in what they called blended learning-- a formal educational program in which a student learns, at least in part through online delivery, with some element of student control over time, place, path, or pace. Some of it may be supervised, and then some of it at home.

The alternative view was called connected learning-- socially embedded, interest-driven, oriented towards educational, economic, political opportunity. Connected learning is realized when a person is able to pursue a personal interest or passion with the support of friends and caring adults. So what else do these two ideas sound like?

AUDIENCE: CLT.

JUSTIN REICH: Yeah, good. So you could have said cognitive load theory and situated learning. You could have said doing Thorndike. You could have said instructionism and constructionism.

This is like the reoccurrence of these two themes over-- like there's always two ideas. And they're. And they're always being reformatted and they're always getting connected to each other.

So this is like the Dewey and Thorndike version of how we're going to make personalization come to life in the world. We'll talk more about connected learning in a week. But mostly, what we'll talk about today is what this blended learning might look like. So Khan Academy doesn't have this anymore. But they used to represent their mathematics content in K through 12 as a knowledge map, as kind of a galaxy.

One of the things that this blended learning version of personalization requires is you have to know all of the stuff that you want people to learn in advance. So if you want to create an algorithmically optimized pathway for people through a set of learning materials, you have to know what those learning materials are, so that you can write the algorithms that drive them through it. That's very different from this connected learning view, which says we should figure out what kids are really interested in and help them create personal pathways through whatever it is they want. So you can imagine that the goal of Khan Academy is to take some individual kid and figure out the fastest, most efficient way for them to traverse pathways through this kind of thing.

People were very compelled by that model. Partially, it was interesting. They were contrasting it.

A lot of times people will critique what they call the factory model of schooling, which is that students come in, in cohorts, they're stamped at the same time. They're moved through the same materials, despite all their individual differences. It's not really true, but there are a lot of folks who will say that schools were organized around factories, in order to generate factory laborers and things like that.

And there are certainly ideas about how we use time and other kinds of things like that go across institutions in society. This is a representation from a keynote. Oh, Sir Ken. I'm forgetting. He's the most popular keynote on TED. I still think it's true, the most popular TED Talk that was ever written. Somebody will have to look up Ken and figure out who I mean by this. But I don't know if this is actually from that or a follow up representation of slide.

So then the question is does this blended learning model have truly individualized thing? Or, are you just kind of like stamping each child with the same stuff in their own rate? They all still are going to get kind of stamped with these materials, but maybe they'll get stamped through the factory at their own individual path.

AUDIENCE: Ken Robinson.

JUSTIN REICH: Ken Robinson. Robinson. Sir Ken Robinson. People make all kinds of crazy claims about these systems. And sometimes I like to share these crazy claims 10 years later because they sound silly afterwards.

So in 2009, Clay Christensen, who was one of the people who defined blended learning, wrote this book called *Disrupting Class* in the business school, do you study still the theory of disruptive innovation? Is that a thing that-- it was like crazy popular a while ago? And I think it has faded.

But they apply this idea called the theory of disruptive innovation. And in 2009, they made the prediction that by 2019, 50% of all grades six through 12 courses would be online. That they would cost a third as much to deliver. That your school system would cost like about a third as much to operate as it does right now. And they would have better learning outcomes.

How many of you were in a school where 50% of all of your classes in secondary school were online or predominantly online? Yeah, zero. Pretty much didn't work out that way. Sebastian Thrun, the quote that Dana saw, was up there.

Sal Khan had an extremely popular TED Talk called "Let's Use Video to Reinvent Education," where he described this vision where kids would sit down in front of individual terminals. They would learn at an algorithmically optimized rate through mathematical content. They still might do things together. A teacher might come and collect students who are stuck in the same thing and remediate them together. Or, take advanced students and do projects with them or things like that. But the heart of their mathematical learning would be individual.

There's one guy who was actually, I think, probably the most wrong of them, who won the 2013 Ted Prize. He got $1 million for this idea. That you don't even need schools or educational systems. If you just give kids laptops, they can teach anything by themselves.

And he had this whole program called The Hole in the Wall Program, where they put computers in public spaces in Southeast Asia. Anyway. There are millions of parents who lived through the pandemic that can confirm that kids with laptops cannot teach anything to themselves.

[LAUGHTER]

Sal Khan is interesting to me because there are millions of people who have watched his 2011 TED Talk about this model. There are many, many fewer people who read an interview that he did in 2019 with *District Administration Magazine.* So *District Administration* is like a little trade magazine for superintendents.

In between starting Khan Academy in 2019, he built his own school called the Khan Lab School. It's a private school. It's in the Bay Area of California. It costs $20,000 or $30,000 or something like that to go there for a year.

But it's basically his laboratory. He can implement any model he wanted. He can pick his own faculty. He can pick his own curriculum. He can recruit whatever students he wants.

And he does this for a few years. And he says, now that I run a school, I see that some of this stuff is not as easy to accomplish compared to how it sounds theoretically. It's taken me and the Khan Academy longer to realize this, but not everyone can easily move to a mastery-based, self-paced learning model overnight. That's hard to do. There are a bunch of efficacy studies for that type of model, and they're robust, but change is hard.

More recently, we're seeing that students put 30 minutes to an hour per week, or one class period per week towards software-based, self-paced learning. Schools will see a 20% to 30% greater-than-expected gain on state assessments. That's exciting because that's a dosage that's very doable in mainstream classrooms. We tell schools to give students 30 to 60 minutes of Khan Academy per week, with teachers doing traditional curriculum four days a week. And you're going to get dramatic improvement. You'll get the best of both worlds.

So this is a pretty big step away from let's reinvent video with education. It's saying, like instead of reinventing education with video, let's do practice problems one day a week. And again, you can think about, is this disrupting education or is education domesticating the system?

But there's something which struck me about this argument, which is like, I think I've heard this before. And one of the earliest places you can find it is in 1994. So there are a group of folks at Carnegie Mellon, who took a bunch of computers that had digital-- they wouldn't have been online network. They would have been digital practice problems.

Brought them into the Pittsburgh Public Schools. And said to the teachers, hey, teach regularly three days a week. And do this two days a week. And apparently, for the most part, the teachers were like, eh, we'll do it one day a week. And they got the experimental classes outperformed students in comparison classes by 15% on standardized tests and 100% on tests targeting these objectives. So roughly the same order of magnitude kind of gains that Khan Academy thought.

So anyway, one of the ways that you could frame that is that with 10 years and $150 million of philanthropic investment, Sal Khan learned what you could have learned with a trip to the library-- which is that they're already existing models for how you can incorporate intelligent tutors and practice problems into what you're doing. And they work pretty well.

AUDIENCE: I'm curious to know-- so we discussed that this individualized tutoring has many benefits. But I'm curious to know if there's any studies that show to which particular subjects they might be more effective or not?

JUSTIN REICH: That's great. Yeah. Yeah. Many.

It really mostly works in math. The current evidence based for reading is very weak. And we'll show more examples of that and read some more papers about that for next class.

So here's a trick. When we try to evaluate these tools, you don't want to look at any individual study, A, because any individual study can be wrong-- well, maybe that's the main reason. Any individual study can be wrong.

So what you do is you do what's called a meta analysis. You look at groups of studies. You say, what are all the studies that have been done with intelligent tutors in math? What are all the studies that have been done with intelligent tutors in reading?

And generally speaking, the only places that we find consistently more positive things, which are not hugely positive, is in math. What complicates that a little bit is that some of the strongest studies in evidence for mathematics have been more recently. Now, one possibility is that that's a fluke. Another possibility is that we're figuring stuff out.

So you have to decide to yourself, like do you want to average over the whole length of studies? Or, do you want to reinforce your ideas based on more recent things. I'll make an argument next class. That actually some of the recent studies in math seem to be pretty robust.

People try this stuff in early language acquisition. Duolingo, I think, has some evidence that they can teach you about as much in Duolingo as you learn in a first year college class. Although, you should probably note that you really don't learn that much in a first year college class in the language.

[LAUGHTER]

Computer science uses tons of things like this. Probably many of you who've done computer programming with Cat Soup and things like that, they probably have hinting and other sorts of things that are baked into that. Doesn't seem to be very involved in later language acquisition. People don't use it that much in science or in social studies. A little bit in chemistry, physics. Some places have some practice problems, things like that, but not about the conceptual understanding more about the procedural fluency kinds of things.

And so what they require, in addition to these item response theory models, which figure out how difficult an item is, is it has to be able to be auto-graded. And because it has to be able to instantly-- it has to be able to instantly assign you what the next item is. And so the only way we can do that is we choose items where we can be pretty confident that a machine can ascertain whether or not you've done it correctly.

You can do that in any field with multiple choice. But multiple choice is-- it's good for some things. It's kind of boring.

AUDIENCE: Oh, I was going to ask. When you said that it's good with working with math, I guess, you answered it later in your speech just now. But what do you mean by it's good with math because there's a difference, a really strong one, between procedural fluency and like conceptual understanding. And when I was thinking about IXL writing this thing, I actually loved IXL.

JUSTIN REICH: Yep.

AUDIENCE: And the reason was because my math teachers were trying really hard, but it was boring.

[LAUGHTER]

And I felt it was like something I could use, where you don't have to do the same grade. You can go past your grade.

JUSTIN REICH: Yeah, yeah.

AUDIENCE: And then you learn a bunch of procedural stuff and you feel like you're so smart or whatever. But that's not true, because procedural fluency is not--

JUSTIN REICH: It's not mathematics.

AUDIENCE: I mean, it's definitely-- yeah, it's not really math.

JUSTIN REICH: I mean, a riff that I'll give you a little bit later in the semester-- so in the Common Core State Standards for Mathematics describe mathematical modeling as five steps. There are five things mathematicians do. They find a problem in the real world. They arrange that problem in some kind of structure, like an equation, or a table, or a schematic. They resolve the computation in that structure. They make a claim about how the answer relates to the real world. So it's 47 board feet, or 47 kittens, or 47 acres. And then they explain their reasoning.

Our auto-graders can only assess one of those five things. Our auto-graders basically can only assess whether or not you like address the computational part of things. They basically don't work for the other four.

If you use mathematics professionally, the only value you have, as a human being, are in the four things the graders can't evaluate. If you use mathematics professionally, you probably have machines compute all the answers of the things that you're doing. The value that you, as a human, bring is in figuring out what problems are interesting, and setting them up, and explaining them to other people, and putting the answer into some kind of context. So I think you're absolutely right.

Now, what do we mean when we say it improves math? Almost always what we mean is that in a randomized controlled trial, people in the control condition get some average score, usually on an annual state test. And people in the experimental condition get a higher average score, again, on the same state test. That's what we usually mean by math that works-- by having a thing work in math, or any other subject, or things like that.

We might not use a state test. We might use some other particular evaluation or things like that. But that's almost always the way these things are evaluated.

And if those tests-- those tests are called math tests-- but they don't test you on everything, that's important in math. And we'll get into that more as we go along too. So you've identified a crucial issue.

Let me try to give you a few other things to send you on your way with. There is a wonderful book by Morgan Ames called *The Charisma Machine,* which studies the One Laptop Per Child Program. It studies a particular implementation in Paraguay, which was kind of a cool country to study because you basically can know everything that's happening in Paraguay. It's kind of a small place. And Morgan was embedded there.

She argues that there are two kinds of stances that people can take towards technology. One is the charismatic stance, the idea that these technologies are going to be new, and different, and transformative. And that the future will be brand new and different because of these things. And that's what Sal Khan sounds like in his TED Talk.

An alternative stance is the tinkering stance, which is what Sal Khan stands like sounds like in his district administrative interview. That existing systems domesticate new technologies that a pretty good guide for the future of schooling and education. Technology is the past. And it's not that we can't make things better. But that making things better is hard, and it takes a lot of time, and it involves building capacity of the community.

You could think of failure to disrupt is basically a celebration of the tinkering stance, which you don't have to agree with. But one of the hearts of the argument is that charismatics don't really help education systems. Making huge promises that we can't deliver on is not helpful. It diverts resources away from where they could be most useful.

A much more useful thing to do is to be real realistic with school systems about what's possible to accept the fact that usually the things we improve are only in some subjects, but not others. And not even in the entirety of those subjects. But only in part of those subjects. And only for certain kinds of students in certain kinds of contexts.

And it's still worth pursuing those things because the way you make education systems better is you just relentlessly try to improve little bits of them by a little amount over, and over, and over again. If you do that long enough, they get better. But if you want the underlying argument behind the whole book is like stop trying to disrupt things and instead, accept the limits of what can be accomplished with education technology. But also, recognize that even if the improvements we can make are small, small improvements compounded over lots of students, over a long period of time really matters.

I want to say, briefly, and maybe I won't finish this, but personalization was a pedagogical idea. But it's also connected to broader political economies. I think I first brought this up when we talked about instructionism and constructionism too.

That these pedagogies can be aligned with values. The instructionists say learning is hard. The constructionists say learning is natural and easy.

That therefore, schools should be disciplined, rigorous, controlled. Schools should be free, democracy-inducing. There are values that get associated with these things. And there were values that got associated with personalization, in particular, the emphasis on the individual as the main unit of analysis when thinking about how to improve schools. To me, it's not at all clear that that's right.

So one thing that people thought about a lot-- and this related to MOOCs, and intelligent tutors, and things like that-- is folks have said like, it's crazy how many different things we ask teachers to do. They need to design assessments, design lessons, grade assessments, give instruction, coach people, provide what the British call pastoral care, which is like taking care of people, and making them feel good, and helping them when they cry, and put on Band-Aids, and things like that.

Why on Earth would we expect an adult to be good at all those things? What if some people are just really good instructors? What if we just have these rock star teachers, like Sal Khan and Sebastian Thrun, who are just better at doing direct instruction? Why are we asking every teacher in the country to be able to explain math, when Sal Khan is really good at explaining math?

And then, we could unbundle that part of their work out. And instead, just have them focus on the things that Sal Khan can't do, which is putting Band-Aids on kids, and grading their feedback, and talking to their parents, and those kinds of things. So not crazy at the start of it.

People have taken this idea even further, which is something like, what if we just unbundled schools entirely? Why do we pack all these different functions in schools? Why don't why don't we let people gain learning experiences wherever they want to?

There is a great leftist thinker named Ivan Illich. We're going to read some of his book,*Deschooling Society,* later, which was written at the dawn of personal computing as an incredible prediction about the future of learning online. Totally extraordinary.

But he was very taken by the ideas of this guy named Milton Friedman, who's a very famous economist, who believed really strongly in the power of markets. That governments weren't really good at solving problems. That markets were really good at solving problems.

What if we got rid of schools and just had people engage in a marketplace of learning activities? What if we unbundled the different functions of schools? Why do you have to take math and English and physical education and sex education from the same institution? Why don't you just let people buy those learning experiences from wherever they want to? The horseshoe is here because this is part of the arguments where people on the left, people on the right, suddenly found themselves in of strange convergence around personalization.

Maybe I'll pass this just to-- so the pedagogical ideas of personalization got connected to a broader political project-- which is enormously successful in the United States, particularly in conservative states right now-- of trying to refashion school systems with less of a focus on schools and much more of a focus on individual students. A very popular idea among people who advocate for this thing is to say, why do we give monies to schools to educate people? What if we took that money and gave it directly to students?

Sometimes these systems were called vouchers. Like, don't send people to public school. Give them a voucher to buy any school they want. It turned out the word voucher was extremely unpopular and evoked a voucher that you would get like in an airport when your flight is canceled that doesn't pay for your hotel and things like that.

For a while they experimented with this idea of student backpacks. Like, the money would go into a student backpack. But that evoked this idea of backpacks full of cash, which was kind of unseemly.

So the term that folks use right now is to fund students instead of systems. Give money to individual students. These are all the states in 2023 that passed or were considering legislation that would say, we're going to take your property taxes. We're not going to give them to schools. We're going to give them to individual kids.

And the individual kids can then use those dollars to buy whatever public school they want. Or, to buy a parochial school. Or, to pay more money and buy a private school. Or, any kind of things like that.

AUDIENCE: Were those funds given to all students? Is there a criteria?

JUSTIN REICH: The ideal, the ideal model is that everyone would get them. Like, if you believe in this free market system, the only way public schools should exist is if they can compete in the market for other kinds of schools. You can also imagine you don't even need schools. Like, what if you bought your math from Khan Academy, and your health class from CVS, and your language class from Rosetta Stone, and your sex ed class from the Big Valley Creation Science Museum, and your English class from the National Writing Project, and things like that?

And this is like a broader political vision of what schooling could be in the future that online learning enabled. And to some extent, parts of it are enormously successful. I would say, the pandemic-- because people basically hated online learning, as a whole-- threw cold water on a whole bunch of these things.

But a thing I want us to keep coming back to as we talk about things, like personalized learning, is that they can be construed as pedagogies. But these pedagogies are almost always connected to broader political movements about how we organize schools. The most political question you could possibly ask is how should we raise our children? In some ways, it seems like an extremely technical question, but it is a deeply moral, value-laden question as well.

OK, we will continue this a little bit, and say some more things about it, and look at some more-- We'll probably get pretty deep into the evidence in the paper that you read, trying to get at some of the questions that Mari asked before, of what is the evidence base for how well these things work? Some of Avril's questions, like what does it mean to work? We'll do a bunch of that with intelligent tutors on Monday.

Have a wonderful weekend. I look forward to getting and reading all your papers. And if I can help you with anything, let me know. Thanks, everybody.