[SQUEAKING]

[RUSTLING]

[CLICKING]

JUSTIN REICH: I'm very interested to know your experiences from last class, what your thoughts were on the NETP discussion and the small group conversations that you had. Did anybody find themselves in conversations that were of interest?

AUDIENCE: I think my group, it was a lot of discussion on how they themselves are trying to bring about these new innovations. But a lot of it's like teacher lashback. And some people are having a really hard time moving forwards, and then some people are doing a good job. And it was all of them agreeing that they need to get those who are proactive about it all together.

I also thought it was interesting, I kind of proposed a question to the group about how they see all of these ideologies playing a part in higher education. A lot of the times, specifically the research that you guys do, is kind of focused on K through 12. But how can this really be implemented in colleges?

And especially at a university like MIT, where you have professors being hired not because they're good teachers but because they're experts in the field. And I think that it just kind of prompted an interesting discussion about where schools need to prioritize, whether they're research institutions or educational facilities.

JUSTIN REICH: Cool. Other folks? What else did you end up talking about with your new education school colleagues, or what else was interesting to you about the National Education Tech Plan discussion or anything else? Ty, and then Omar.

AUDIENCE: Yeah, it was interesting. Omar and I were in the same group.

AUDIENCE: Yeah.

AUDIENCE: So we'll see if this overlaps. But there wasn't a ton of conversation in our group. But they did ask me about my time as a software engineer and how we thought about iteration in the software development space. And then they tried to start making parallels to how they try to implement it in their own schools. And we talked a little bit about some of the differences and where things might be more complex or harder. So it was an interesting conversation to try to take my experience and reapply it.

JUSTIN REICH: That's cool. That's great.

AUDIENCE: Yeah. So again, there wasn't that much discussion. You kind of went over what I was going to say. So I guess I'll touch on the first part of the session, which is the big conversation. I was reading the chat. And it was pretty cool to see everybody commenting on everything and seeing a bunch of examples and seeing either frustrations or revelations that they never realized about the message of focusing on not the technology itself, but what we can do, and then how technology can help and what we're trying to do first. And that revelation for a lot of professionals was pretty cool to see develop in the chat.

JUSTIN REICH: Yeah. Yeah. You get to watch human development in real time. People encounter where they're-- I didn't follow it that closely because I was talking. Were there frustrations that were-- anything on the frustration side that stuck out to you or seemed memorable?

AUDIENCE: Not necessarily frustrations, but sort of like, oh, that's why this is happening, or, OK, now this is starting to make sense. So it's sort of like their frustrations were cleared up, so to speak.

JUSTIN REICH: Great. Good. Hi, Ramon. You've got to come up here and hang out with me. That's what happens when you get towards the end. Yeah. Asa. Asa and I were in the same group. We had a spicy one.

AUDIENCE: Yeah. So a lot of the discussion was about-- a lot of the people in our group are the people designing the structures that they were trying to implement. And something that was interesting was this repeated, oh, we design something, we send it to the administration, and they're like, no, that's not exactly what we're looking for. Try again. And it's just kind of constantly trying to get something that they're like, OK, I like this, as opposed to them being able to effectively communicate the points that they want included, which was very interesting.

JUSTIN REICH: Well, part of the way I read our group is that we had some people who were kind of middle-level leaders, and they were trying to convince more senior leaders to make change. And the senior leaders were much slower and less interested in that, which happens in basically every kind of institution. When you go and visit an institution, one way to think of it is it is designed exactly to do what it's doing right now.

It functions the way it functions because there's some set of actors who want it to function that way. Often, those folks are people with power and control. And it exists the way it does because that's what they want. And then new people come along-- new people live in that environment and they're like, well, this could be better, and this could be better, and this could be better, and this could be better.

And then more senior folks are like, eh, but we like the way we've done it all the time. And so it's not uncommon for people coming up-- I think really healthy organizations recognize, oh, we need to be constantly improving. And constantly improving means throwing away and destroying things that I have built over my career, because that's the only way you get better.

But it's pretty understandable that people wouldn't feel that way. It'd be like, I've spent my career building this thing. Why don't we just keep doing this thing? And so they were struggling with-- and an interesting place where lots of people and lots of organizations find themselves is, OK, we need to do something different, but the people in charge aren't really supportive. How do we do it anyway?

Where change comes from-- I don't know. Maybe I mentioned this. I can't remember if I mentioned this particular story, but one of the people that I worked with on some of the content that's in Iterate is this guy Peter Senge, who's at the Management School at Sloan. And a neat thing about working with him is he's done a ton of stuff in education, but lots of stuff in many other sectors.

And it comes up periodically, like, man, teachers, lots of people in education, just don't feel empowered to make change. They feel like, look, I got hired in this particular role. I'm a math teacher. I'm a history teacher. I'm a chemistry professor. It's not my job to fix the university.

And Peter once said something to me along the lines of, everyone in every industry feels that way. CEOs don't feel like they're empowered to make change in the institution. Nobody feels like they're empowered to make change in institutions.

But change still happens all the time because people who don't necessarily feel empowered still take it upon themselves to try new things, put new things in the world. And I don't know. It's a story I like to retell educators because it's like, this is not an education-specific problem. This is a human problem.

AUDIENCE: Yeah. I thought what Lou said, from the University of Kentucky, was really fascinating because I'm actually from Kentucky. And I worked at an organization with her before called the Kentucky Student Voice Team.

JUSTIN REICH: Oh, really? Cool.

AUDIENCE: And the way that they impact change is by putting students in stakeholder positions. So instead of influencing change through ineffective ways, like administration, they put students at the forefront. So she's a really big leader in driving, I guess, educational change in Kentucky. So I thought it was cool.

JUSTIN REICH: That's great. Oh, I'm glad you had that connection. That's fun. How did you-- so she, at the university, ran the student voice thing that high school students across Kentucky could participate in and stuff or?

AUDIENCE: Yeah. So it was born out of something called the Prichard Committee, but now it's an independent organization. And the, I guess, organization has adults and younger students as co-peers. They put them on the same level of the hierarchy to work together to, I guess, craft a bunch of initiatives to improve Kentucky schools.

JUSTIN REICH: Yeah. Yeah. There are all kinds of cool-- education technology has tons of cool stuff like that, in part because lots of young people can get interested and excited by technology and so bring them in into leadership roles, partnership roles.

Cities have that too. There's a group in Boston called the Hyde Square Task Force, which does all kinds of-- they usually do more, I don't know, community organizing, kind of adversarial, like why are you doing this to us? Why are you doing it this way?

They have a whole campaign they're doing right now against either Shaw's or Stop & Shop, which is separate from their education work. But they've gone to a bunch of grocery stores in neighborhoods around Boston and bought the same thing in each store and basically found that in some minoritized, poverty-impacted neighborhoods, the groceries are more expensive than they are in Newton and Wellesley or stuff like that. And they're holding a-- Stop & Shop is not happy with these kids being a thorn in their side. It's great.

AUDIENCE: [INAUDIBLE]

JUSTIN REICH: Yeah, yeah, yeah, yeah. They're pretty good at getting press for what they do and things like that. They'll probably have to respond at some point. Good. Well, I enjoyed letting you all connect with them. And it sounds like the meeting-- every time you go into breakout rooms, it's uneven. But hopefully it's a good sense for you to meet some of the people who are in higher education, who are trying to make the changes that we're going to talk about, in the past few weeks and for the rest of the semester. So hopefully that was a neat opportunity.

Why don't you take a couple of minutes, before I launch into things, just to chat with each other, and then we can surface some of these ideas. But the learning journal prompt that I had for you was to talk about, what role does technology play in your MIT education thus far? And so talk to the person next to you. Some of you might not be from MIT, or some of you might be in graduate school and so you have some undergraduate connections to this as well. Those things are all fine. Technology and higher education.

Typically, the things that are most useful to talk about are either systems or tools or things that you think are particularly helpful or useful, systems or tools or things that are particularly damaging or harmful or pointless or a waste of your time, and then also anything that has started to seem really familiar to you, but actually you think has interesting, unfamiliar qualities or things that feel standard and boring, but actually they're important, maybe in ways that we don't want to think about.

So turn to the two or three people next to you, talk for a few minutes about, if you were to explain to someone not from your undergraduate institution the role that technology plays there, what would be the couple of stories that you would tell? Ready? Go.

[SIDE CONVERSATION]

JUSTIN REICH: OK. Come on back.

AUDIENCE: You need to learn the technology. Because of that, they believe--

JUSTIN REICH: Be great to keep trying to hear from everybody. So would love to have some folks who haven't shared yet. Would love to hear, what are some MIT highlights or lowlights or distinctive parts of-- or in your undergraduate program, distinctive parts of technologies? What do you got, Jaron?

AUDIENCE: My group was discussing MIT's use of Canvas. And pre-COVID, MIT had this weird proprietary thing, where they had their own--

JUSTIN REICH: What was that called?

AUDIENCE: Stellar.

JUSTIN REICH: Stellar. Yeah.

AUDIENCE: Yeah. So they had-- each class had their own different Stellar website, and it wasn't standardized at all. And it was kind of a mess. It had this weird, outdated, 1990s internet-era aesthetic to it. It was pretty horrible. And then they had this proprietary thing, called the Learning Module, which was basically Canvas, like MIT was just trying to make Canvas.

But then during the pandemic, I guess they decided to make Canvas a much more standardized thing. And so I find that to be very helpful for keeping everything organized and having assignments done through Canvas, as opposed to being like, oh crap, what's that website I have to go to? Search up Stellar MIT. And it was weird.

But I feel like, because of that, a lot of professors don't fully utilize all the different things that Canvas has to offer, especially when it comes to grades and putting grades. Professors and TAs don't care about inputting grades. And a lot of students, I feel, would really like to see real-time feedback on their grades and how that actively affects their final grade in the class. But that just isn't a-- professors don't do that.

JUSTIN REICH: Yeah. Yeah. And I mean, another thing that's unusual-- we'll talk about this more as the semester goes on, but it does seem a little weird that you would have the exact same Canvas template for a graduate seminar on chemistry synthesis and an undergraduate seminar on Renaissance poetry. And if you're studying really different kinds of things, does it really make sense to have the same structure for all of those different kinds of things? It seems like there should be some differences there. What were you going to say, Emily?

AUDIENCE: We talked about MITx, which is like-- physics use it, and then a lot of math classes use it. And I like how it's-- it's sometimes recordings of a concept, introducing you to a concept, or it could be in writing, but it's not as dense as a textbook, where you're kind of like, oh, I don't want to start reading this. And then it's like, right after, when they introduce it, you have check questions, where it's kind of checking for your understanding.

And it immediately tells if you're right or wrong, which is really nice, because for math, I feel like-- so when you're told, oh, this is the right answer, you're more focused on the process of getting to it rather than the answer itself, which is a lot more beneficial when you're doing math. You care about the process of how to get to that answer and not the answer itself. So I think it's really, really nice to have that platform for especially math classes.

JUSTIN REICH: And you could imagine, for all of those autograded problems you've ever done, five years ago, you very likely would have done those Psets on paper. You would have turned the Psets into a TA. A TA would have gotten hundreds of them. It would have taken them a week, 10 days, two weeks to turn around or something like that.

And so, by the time it gets handed back to you-- you might get the answer key sooner. By the time you get-- it can be days or weeks after doing a problem that you figure out whether you got it right or not. And you just forgot how you did it or what you were thinking about at the time. So you could definitely imagine some real advantages to that kind of instant-- it can change the way study groups operate too, both for good and bad.

But you could imagine that study groups previously would have been like, OK, let's all write this Pset. They all write the Pset and turn it in. You're like, I hope that worked. But when you have the autograding, you can be like, wait, half of us did not get this right. Why didn't we? What can we learn from each other? There's all kinds of ways that that instant feedback can change the relationships that you have with that learning. Any other thoughts? Yeah, Sabrina.

AUDIENCE: I was going to say, something like Notability has really transformed the way I, for example, organize all of my classwork and the fact that everyone uses their iPads now instead of going to paper and pencil. I think, yeah, just the fact that we can have all of our lecture notes and then upload it to Notability. We can annotate it, and then do all of our homework on here too, and be able to compare screens and things like that.

And I think that's really-- before, I only ever really used paper and pencil. And then switching-- the fact that MIT gave out iPads to everyone. And then, because we have the resources to have Notability for free and the fact that we submit everything electronically now has kind of been a little bit of a game changer.

JUSTIN REICH: Does Notability have any social features? Do you just have your own Notability, or are there ways--

AUDIENCE: They've recently added some share your notes kind of gallery search thing.

JUSTIN REICH: Good. Cool.

AUDIENCE: There's also the good old screenshot-- the iPads are usually iCloud. You can just text it.

JUSTIN REICH: To the next person. Yeah, yeah, yeah, yeah. Good. Goo.d

AUDIENCE: You can dual screen on the iPad, which isn't necessarily an aspect-- well, Notability you can also dual screen. So you pull up someone else's work.

[LAUGHTER]

JUSTIN REICH: There's some very specific applications for some of those kinds of things. Good. Other thoughts? What do you have, Omar?

AUDIENCE: We had the same thought of CAT-SOOP has been kind of revolutionary, I guess, in a way that--

JUSTIN REICH: I've heard of this, but you've got to tell us what it is again.

AUDIENCE: CAT-SOOP is an automatic tutor for 6.01 problems.

AUDIENCE: For 6.01?

AUDIENCE: It used to be an old introductory computer science course that was required for most physics majors, but they phased that out three years ago. I don't remember what 6.01 specifically was, but that's what CAT-SOOP stands for. It's a recursive acronym.

But I guess, in a way-- I never got to use Stellar. But in a way, that's sort of become the new Stellar in the sense that each class has their own different website and each upload problems on there. And I have found it to be kind of nice, because it also has an autograder, and it lets you submit stuff for recitation in class. And I found it's pretty great. I like the interface, but I just hate the fact that I have to bookmark every single different website or else I forget them.

JUSTIN REICH: Uh-huh. Good. Some of those logistical things.

AUDIENCE: I mean, to add to that, different course-- I mean, I've seen it mostly in course 6. Yeah, different Course 6 classes use it to different degrees. And there is a little call for it there. There are some classes where the entire class is on there. And then you go to your class in the basement with 40 people, and they're all trying to log in at the same time so that they're marked as present, and they're starting their lab, and everything just crashes.

JUSTIN REICH: That is so comforting to me because I run this system called Teacher Moments. And we have similar problems. But I'm not an MIT Computer Science professor. And the fact that their shit doesn't work either is very-- that's very comforting to me.

AUDIENCE: I think that there's one thing that we kind of discussed, which is an application of the MITx, is typically, most freshmen at MIT take the 8.01, 8.02 TEAL series. And I feel like that gives this false advertisement of how education technology is used here at MIT, where they give you this flipped classroom idea. And some kids love it. And then you switch into another class, and you never see that type of learning again.

And you're like, well, I liked that, so where is it? And for me, who struggled through it because I was a student that was kind of behind going in, then I switched to my Course 16 classes, where it's a professor lecturing in front of you, and all of a sudden I now understand the concept. It's like, why did I lose a whole year? So it's kind of like that back and forth between, are you going to continue to implement this in other ways, or are we just stagnant in this one idea behind it?

JUSTIN REICH: Yeah. Yeah. Yeah. That's really-- I mean, TEAL is an experience that a lot of you have had. If you're not from here, TEAL is a way that they do introductory physics teaching. It came about because of high failure rates, particularly from people who came from backgrounds where they were less well prepared in physics.

And so 8.01, 8.02, these introductory physics classes, would be taught as lectures with problem sets and things like that. It also actually-- there's a long-- we won't get into it-- a really interesting tradition of research in physics education, which, I don't know, three decades ago maybe, discovered that when students, even at really good universities, take introductory physics, historically they were actually less Newtonian in their thinking at the end of the class than at the beginning.

They got good grades. They could solve all the kinds of physics problems. But then they gave them this test, this assessment called the Force Concept Inventory, which was a bunch of conceptual questions about how force works, and students would actually do worse at the end of the class than they would do at the beginning. So there was this sense that you could spend a whole bunch of time teaching people the procedures of physics, and they would actually come to slightly more misunderstand the concepts as a result of that, which is bad.

And so active learning, learning environments where students are asked to not just listen and take notes and then do problem sets, but to engage during the conversations about the material, were shown to improve that. And then TEAL stuck around because, while people have individual experiences with it, there are fewer students who failed 8.01 and 8.02 after TEAL was implemented and given a few years to ramp up and work than there were beforehand.

However, just because, on average, the TEAL system is more likely to have more students persist, doesn't mean that for any individual student-- individual students can still not like it, and it can not serve them well. And it can not serve them well because of their background preparation or because-- I mean, lots of people who come to MIT end up here because they're pretty good at teaching themselves stuff through lectures. And so alternate methods, when the physics department is trying to think about what to do with that, these are all the kinds of trade-offs that they're considering. What were you going to say, Howard?

AUDIENCE: Slides, especially when you're taking classes that are Course 6 or math. When professors use slides, I feel like it affects my learning because I like when they use chalk and board. And it's just walking through it because, one, it slows them down.

JUSTIN REICH: Yeah. Yeah.

AUDIENCE: And two, you also kind of catch up with them. But if they're using slides, they go very fast. And second, you just have to-- I don't know, it makes the learning process a different thing.

JUSTIN REICH: Yeah. Yeah. No, I think it's really interesting. They're probably like-- they're less likely to have errors on the slides than they are when they're working things out by hand. However, it's not totally clear whether or not errors are a bad thing in that. Sometimes people note the errors in real time, or they note them in real time, and they fix them and discuss them.

But definitely, if you can only talk and move at the pace at which someone can write, that can have different kind of advantages. I mean, the slides are kind of cool in that they get automatically sent to you. They can be sent to you in advance. You can take notes directly on them.

Is taking notes directly on them actually better, or is it better to have to hand copy, pay attention to what's going on there? These are all great questions, and they're all questions that actually have research behind them. There are folks who come up with experiments where they test all of these different conditions.

What do we do when we tell students to try to copy everything down? What do we do when we tell students to summarize? What if they give them stuff in advance? What if we let them have computers? What if we take away their computers?

Actually, some of the best places to do this research end up being military schools, like West Point and the Naval Academy and stuff like that, because they have a lot of required classes, and because you can be pretty sure that the students will do what you tell them to do. You assign them to either condition, and they do what they want to.

Good. So an interesting thing about our own experiences is that our own experiences are really important sources of data for understanding education technology. It's important for us to look through the lens of our own learning experiences. And they can be very informative.

The other thing to remember is that if you're studying at MIT, you're probably weird. There are probably characteristics of you which are not typical. Like if you generally find classroom learning pleasant, you are unusual. If you think to yourself, man, I really like just kind of learning stuff and figuring out on my own in academic material, that is unusual. Most people are not good at those things and don't find them enjoyable.

So it can be helpful to bring your own experience. But it's also important to recognize the way-- and I went to private schools my whole life. I've had an extraordinarily privileged educational upbringing. In lots of ways, I have to recognize how that upbringing does not prepare me well to understand the learning experiences of most students who go to K-12 schools and public schools in the United States and things like that. So be conscientious of that as we do some thinking. But this stuff is good. All the things you're talking about are things we'll keep trying to make sense of.

Failure to Disrupt. This is a book about large-scale learning, learning environments with many, many learners and few experts to guide them. And I would say, the heart of what I'm trying to do in this book is to demystify education technology for people and to say, with every generation of new technologies, there will be folks who come along that try to go to schools and say, this thing is totally brand new. This is disruptive. This is innovative. This is a game changer. This is going to transform education.

And my job is to be like, eh, probably not. It might be helpful, but it's very, very unlikely that it will be any of those kinds of things. One of the ways to demystify technologies is to show where they come from, is to say, these things have patterns. The patterns are recognizable. They are patterns, not just in how these things are designed, but how they get implemented and what kind of effects they have. When new technologies come along, we don't have to guess out of the blue how well they might work.

We know roughly how well education technology works in different kinds of circumstance. Now, new things-- there will be new things that are invented that are, in fact, different. But most new things are just a little bit new. They make just small modifications, small advances off of past things.

And then the second half of the book confronts the challenge, why is it so hard to make progress with education technology? Why are things not disruptive? Why are they not transformative? Why are they not game changers? And I think there are answers to those questions. I think there are challenges that we have as a field yet to figure out how to tackle. And if we study those challenges and make sense of them, then we could probably do a better job moving past them.

So the first half of the book looks at these three genres of learning at scale. It says that most education technologies, especially the ones where you try to teach a lot of people with very few experts, fall into one of three buckets. And you can figure out what bucket each thing is in by asking the question, who guides the sequence of learning activities?

When learners do stuff, they happen in an order, one after the other after the other, and there are really three sorts of ways that those orders unfold. The first is instructor-guided learning at scale. So there can be some expert or team of experts who says, you should learn things in this order. Here's part 1, part 2, part 3, part 4, part 5.

And maybe learners don't go in that order, but overwhelmingly they will. And there's some logical sequence to that. So I call those things instructor-guided learning at scale. A bunch of what you read about for today-- massive open online courses, any kind of self-paced online learning falls in that bucket.

The second big genre is algorithm-guided learning at scale. So that's when a computer poses you a problem, you answer that problem, and the computer evaluates your performance. And then based on that performance, it gives you either more difficult problems or simpler problems, or the same kind of problem, or shunts you in some kind of different direction.

But basically, the computer evaluates your performance, decides on the basis of that performance what the next item in a sequence of activities should be, and then you go do that forever. You are probably-- I don't know. When I taught this 10 years ago, maybe students would have dabbled with these things, but it's far, far more common now.

If you in school ever used DreamBox or IXL or Khan Academy, almost all of those things are some version of algorithm-guided learning at scale. A bunch of the testing that you've done, if you've taken the computer-based GREs, other things like that, they use similar technologies.

The third bucket of things we call peer-guided learning at scale. So if any of you have ever played around with the Scratch programming community, there's no instruction in Scratch. There's no Scratch University or Scratch lesson 1, lesson 2, lesson 3. And that's very intentional and by design.

Instead, you're immersed in this community of peers. And if you go to the home page of the Scratch website, there are featured tutorials and featured projects and things like that. And the way you figure out Scratch is that you think about some things that you want to do, and then you find some other people who've done that kind of thing, and you copy them, you converse with them, you take their project and you modify it, but you basically design your own pathway.

There are lots of other learning environments, Stack Overflow, other kinds of communities of practice. The one that I talk about at the beginning of the book is Rainbow Loom. Any of you ever played with Rainbow Loom when you were kids? Yeah.

So when you bought a-- did I tell you this story yet? When you bought a Rainbow Loom, there were 10 cards in the packet. So you pulled open the packet. There's a bunch of these little rubber bands, a little-- what do they call that thing? Frame, to stitch the rubber bands on.

And then there are 10 cards that show 10 different kinds of bracelets that you can make. If you get really into Rainbow Loom, 10 different kinds of bracelets is not enough kinds of bracelets. You have to learn more different ways of doing it. And the main way you'll learn that is through YouTube.

You'll go to this-- and here's the thing that boggled my mind about Rainbow Loom. So there's some dude who is in Michigan. He was an automotive engineer or something like that who was like, in my country, this is the way we make bracelets. And he comes up with some CAD designs, and he sends them to China. And China manufactures zillions of these things.

And they put them on shipping containers, and they send them to his distribution center. And eventually, these packets, these little boxes of Rainbow Loom things get sent all over the world. It's a total supply chain miracle. The fact that some dude in Michigan just has an idea and is like, let's have people all over the world buy these things, and they do, is amazing.

But simultaneously to that physical supply chain infrastructure, this giant global community of Rainbow Loom learners emerges, where there are people who are running little classes at art shops, and they're posting videos online, and they're sharing ideas with each other, and they're creating little Facebook Marketplaces.

And the only way Rainbow Loom could grow is if that learning network grows alongside it. That is miraculous. That is an amazing feature of online learning, that people could invent a tool to do this kind of practice and a community could develop to teach each other and themselves this practice.

I think there were-- oh, the other thing I really liked about that, which I think I mentioned, is that there were these two girls-- I think their names were Ashley and Steph-- who made Rainbow Loom YouTube videos. And they got millions of views. And you could compare their videos to the actual Rainbow Loom manufacturer videos. And these girls were getting like 10x the number of views that the actual Rainbow-- basically, kids would rather learn from these two random girls.

They ended up being from Philadelphia. They're very good at protecting their anonymity, at least for a while. One of them eventually became a makeup influencer, and then they revealed herself. But I find these global networks incredibly fascinating and very, very difficult to integrate in schools, for reasons that we'll explore as we go along.

So if you buy that there are these three big categories, a thing that we'll do over the next few weeks is we'll look at how there are similarities within these categories. So for instance, in instructor-guided learning at scale, there typically are two key technologies. There are two technologies that show up over and over and over again.

One is a learning management system. So a learning management system-- Canvas, Blackboard, edX, Moodle, Stellar, or a zillion other things-- they're platforms that organize learning materials. An unusual feature of learning management systems is that they have a feature that people who study products called feature convergence.

Essentially, it's very difficult to patent or have intellectual property around components of a learning management system. So anytime anyone invents something good, everybody else copies it. So they're all basically the exact same system. You buy them from different vendors, but they're basically one learning management system.

And then the second kind of crucial feature of online learning management-- or instructor-guided learning at scale are autograders. So you have to be able to give-- if you have lots and lots of learners, if you want to be able to give them feedback, if you want to be to certify their learning in any way, you either have to spend zillions of dollars hiring people to grade their work, or you find ways of having computers grade their work.

Now, computers can-- we'll talk about this at length. Computers can grade some things, but not others. Computers are really good at answering-- at evaluating questions where the answer is well known and certain. They are much less good at evaluating anything which has a kind of subjective component to it.

One way to think about this is, autograders are great in early language acquisition and very rapidly become useless in later language acquisition. So they can tell whether you've spelled "hola" correctly. We even have some pretty cool ones that can tell whether you've pronounced "hola" correctly.

We can give you a multiple choice question to see if you can recognize the audio recording of "hola." Eventually, however, what we want to know are, what are the key themes in *Don Quixote?* And that we don't have very good autograders to be able to evaluate and so forth.

I would say, in addition to this technological infrastructure, these genres of learning at scale, they tend to align more closely either with direct instruction kind of folks or apprenticeship constructivism kinds of folks. The instructor-guided learning at scale people, they tend to be Thorndike, direct instruction, cognitive load theory kind of people. They tend to be pail-filling kinds of folks.

Algorithm-guided learning at scale has similarities but differences. So the crucial technology behind algorithm-guided learning at scale is a set of algorithms called item response theory. This was developed in the 1980s by Educational Testing Services, the people who make-- what do they-- do they do the SAT or the GRE? What test does ETS make?

I don't know. They make tests. And the basic toolkit of item response theory has proven really quite robust. All item response theory does basically is it lets you figure out how difficult an item is. It's a way of quantifying how difficult an item is. If you can quantify how difficult an item is, if someone gets the item right, you can give them a more difficult item or less difficult item.

It was actually originally developed so that you could give people tests of equivalent difficulty without giving them the same test. This proved important, like when we had national testing and we built communication networks, because, in theory, somebody could take a test in Portland, Maine, and later that same day, someone would take it in Honolulu, Hawaii. And there's just enough time in there for someone to call and send all the questions and answers and things like that.

And so it, in part, came about from test security. You want to be able to make claims about people's ability. And one way to do that is to give everyone the same test. Another way to do that is to give everyone tests with different items but of the same difficulty. And so we had to come up with some statistical toolkit for doing that.

What we came up with in the 1980s and 1990s, we've modified it a bit, but we still pretty much use today. We know a bunch about its strengths and weaknesses and how it works. Most of our autograders, just now maybe they're starting to improve a little bit. Most of them haven't improved that much in the last two or three decades.

In some specific areas, some parts of language acquisition, some parts of computer science, maybe they've improved better. But these technologies, for the most part, are pretty stable. When someone has a new entrant-- I mean, you'll read more of this story in chapter 2. But there was a company called Newton, which said that they could take any body of educational content and turn it into an intelligent tutor.

And they thought that their tutor was absolutely amazing. The founder described it as something like a magical robot tutor in the sky, knew exactly what you were thinking and so forth. So he was making all these totally outlandish claims. And then his engineers had a blog about what they were building.

And one of their blog posts was something like, using two-parameter item response theory to evaluate items. They were basically like-- so the leader is out there being like, this thing is totally amazing. And the engineers are like, here's the very well-established technology that we're using to do the thing that we are selling you to do.

The peer-guided learning at scale looks pretty different from the other two. Peer-guided learning environments tend to be more apprenticeship-oriented. They tend to be more wrapped into situated learning, things like that. They tend to have a different technical infrastructure. Instead of being based in some kind of content holding thing, like a learning management system, they usually exist on the web.

And usually, their killer app is not an autograder, but a thing that pulls content together. How do you figure out what the right sequence of Rainbow Loom learning materials is to look at, and things like hashtags are really important for that. In Scratch, how do you pull together and come up with a set of featured projects, or a way of tagging projects so that people can find their way through them?

So these are the three big buckets that we'll explore one bucket each over the next bunch of weeks. The second half of the book, which I guess if this project takes us a good chunk of March, this project will take us a good chunk of April, are four problems that educators and education technology designers run into over and over again, which I'll enumerate quickly just to orient you.

One's missing. Anyway, the first one is the Curse of the Familiar. The idea of the Curse of the Familiar is that it's pretty easy to make technologies that do things that educators already are doing and get them adopted. How many of you have ever used Quizlet? OK.

That's about as universal-- Quizlet was founded by MIT dropout Andy Sutherland, who took a bunch of education classes with us. And he built it to, I think, study French for himself. Quizlet is flashcards. If you went and you gathered a bunch of educational experts around the world and said, what do our kids really need to advance their learning? There is no one who would raise their hands and be like, there's a huge dearth of flashcards.

We just don't have enough flashcards at school. We've run out of index cards, something like that. And yet here's this something-- I mean, they say things like, half of all high schoolers every month use Quizlet. How much does Quizlet improve teaching and learning? Well, if you're replacing regular flashcards with digital flashcards, how much would you expect that to improve learning? Maybe some. Maybe there's a little efficiency there, something like that.

You also might say something like, actually, one of the best things about flashcards is the creation of the flashcards. There's actually something important of learning about writing down the prompts on one end, the answers on the other end. So maybe the paper ones are actually better than the Quizlet ones in different kinds of ways.

But the point is, there's probably no one who would make a bet that human development would be profoundly transformed by digitizing flashcards. But if you look across many of the most successful education technology companies, they do something like Quizlet. They take a thing which is already happening in schools, and they digitize it, maybe make it a little bit more efficient.

There are a handful of projects that try to do something totally different, and many of them fail. And the reason why they fail is it's really hard to convince people in schools to adopt totally new routines. So there are all kinds of visionary educators out there who think, man, wouldn't it be cool if we could teach math in this really different kind of way, if we can teach computer science in this really different kind of way?

And then they build things that do that and people go, that's weird. I don't understand this really new, different kind of way. So a bunch of the things which might potentially lead us to the biggest gains or changes in our teaching and learning are really hard to get people to adopt. That's the Curse of the Familiar.

The EdTech Matthew Effect is that we very often hope that new technologies, especially free technologies, will be-- the term people often use is "democratizing," that they will-- essentially what will happen-- people, generally speaking, agreed that folks who have more resources have had more learning experiences, and therefore have learned more than people with less experience.

But we hope that there are technologies that will disproportionately benefit the less affluent, that they will help poor folks catch up to other people. They'll create new kinds of on ramps. Maybe they help everybody, but they particularly help this group.

What we almost always find is the figure on the right, which is that new technologies disproportionately benefit the affluent, is that they're very likely to accelerate the learning of people who are already advantaged. Many people go into education because they're trying to build a more equitable, just society, and it can be quite frustrating if you keep building stuff and it keeps helping the most affluent people in society secure their position better.

We can document this really well. It's actually, in a lot of cases, hard to understand why it's happening. And we have very little science or research that helps us explain what alternatives would be. We'll give you some examples of some technologies that I think don't do that, that I think do disproportionately benefit people further from opportunity. But it's really hard to figure out why they work.

A third challenge that education technology folks come across all the time is that computers are good at evaluating certain kinds of things. The kinds of things that they're really good at evaluating are those that are routine, that have common features to them, that are highly structured. Computers are much less good at evaluating ill structured kinds of things, things that don't have much form to them, or we don't know what inputs need to go in them or what the final output should look like.

For instance, one of the things that we don't have good autograders for is people's ability to reason from evidence in natural language, either written or auditory. The main thing that we teach you for 16 or 20 years in the education system is how to reason from evidence. The most important things we're teaching you how to do we don't have good autograders for.

Moreover, the kinds of things that computers can grade tend to overlap pretty closely with the kinds of things that computers are good at. If computers are good at things, it's going to be very difficult to make a living doing those things. So we have really good tests for the kinds of things that are probably not so important to teach people, and we have not very good tests on the kinds of things that are really important to teach people. That is a bad feature for an educational system, because autograding of all kinds is way cheaper than human grading.

So we essentially build all of these systems where, conceivably, we're spending money to cheaply evaluate the least important parts of the system. And we're not evaluating the most important parts that people ought to be developing in those systems. So that is the trap of routine assessment.

A really cool thing about computers is that they can collect enormous amounts of data about what folks do and that we can run experiments on people and improve those systems. So every time-- not every time, but 1% of the time you go to Google or Amazon or Facebook or whatever, they're doing some little randomized controlled trial on you. The Buy button is green instead of red. And we figure out whether you buy more from green buttons than red buttons.

And eventually, Amazon, Facebook, they do millions. I don't know. They do many, many of those experiments every year, and their system continuously gets better. There are a couple of problems with doing that in education. The first problem is, if you go to folks and you say that what you want to do is experiment with their children, as we've joked before, people are not that enthusiastic about that as an idea.

It's also not clear that surveilling people constantly in public schools is a good idea for civil society. An exercise maybe we'll do later on is start thinking about all of the data that MIT has about you. And we might start thinking, is it a good idea that MIT has all of this data about people?

Is it a good idea for an elementary school to have all of this data about where people are moving, where they're logging in, how they're learning, their health care, all these other kinds of things? So it could be that collecting huge amounts of data lets us build really cool EdTech products. It also could be that it inducts people into a surveillance society, which ultimately is not good for democracies or civil society.

So in the second half of the class, or the second half of our reading of this book, those are the four dilemmas that we'll spend some time messing around with and exploring. That is an overview of the task of the reading together. And then what we'll do for the last 20 minutes of class is to talk about massive open online courses in particular. But maybe I'll pause back here essentially on these two slides and see if people have any questions or things they want to interject here.

AUDIENCE: For the next slide, when you mentioned the four as-yet intractable dilemmas, when you were studying technology and education, have you found issues that used to be dilemmas and that at some point we were actually able to solve and these are the four that are left?

JUSTIN REICH: Huh. Yeah. So I think there would be some-- there would be access and distribution problems that you might have thought about as being really central to lots of different places 20 years ago that would still-- if we're talking about sub-Saharan Africa or other kinds of places in the world are still serious, refugee camps, places of protracted conflicts, lots of places where access is hard.

But there's also lots of places where we'd be like, yeah, in the United States, pretty much every school has high-speed internet now. And so whereas-- we still have to think about how we do that and how we upgrade it and things like that. But that is a dilemma which has diminished quite a bit over time.

And for sure, some of these dilemmas we've made progress on. I mean, I would particularly say the Trap of Routine Assessment is one where, in the last 10 or 15 years, there are definitely places where you could say, hey, we're doing better automated assessment now than we were before at different levels.

So, I mean, computer science is probably the place where we have the most robust suite of autograding tools. It doesn't cover everything that's important in computer science, but boy, you can automatically evaluate people on a lot of stuff that matters. Yeah. I mean, there's an example in the book of autograding spoken language for language learners, that you can talk out loud and Duolingo can tell whether or not you've pronounced something correctly. That's pretty rad.

And then, I think-- it'll be interesting to see in the next few years, but my hunch is, large language models will play an increasingly large role in at least giving people meaningful feedback on their written products. Whether or not we actually grade with them, that may be a bridge too far. I'm sure we'll use it in some circumstances.

But I bet there'll be many, many circumstances-- if you told me, 10 years from now, every time a student turned in a paper, they ran it through an advanced version of something like Grammarly, which gave them not only feedback about their syntax, but was like, hey, I don't think you have any evidence in this paragraph, you might want to go back and look at that, that wouldn't surprise me at all. And that could help students a lot. If there's someone who can-- if there's an automated bot that can give you reasonable feedback generically about your writing, that would be cool. I'd rather focus on other things than giving you feedback.

AUDIENCE: So I remember you mentioning in one of the slides that computers are not very good at things that don't have as much structure, but with things like LLMs, do you think that that's going to change?

JUSTIN REICH: They will get better. I think there is still-- I think even some of our earliest evidence suggests that these are really thorny problems. So I feel like we're starting to get some feedback about, for instance, people using LLMs to help them in coding. And there's a joke, which is something like, using Copilot's encoding will reduce your initial coding time in half, and then it will double your quality assurance time, basically because not only will it maybe introduce errors, but also the people engineering things just won't understand what the bot is doing.

And the bot is much better at very specific parts of building code than it is in engineering a whole system. And so it makes a bunch of decisions that make sense for a particular thing, but don't make sense for building a whole system. And then somebody has to go back and repair those kinds of things. So in terms of-- I don't know. We'll get into this more when we talk about autograders later.

But Hal Abelson, who's been on the CS faculty forever, has this wonderful quotation in one of his earliest books on computer science, which says something like, computer programming is a language for communicating between two people about methods that's only incidentally meant to be run by a machine. And the idea is that really good code is actually talking amongst people and not talking to the machine.

Our autograders are really good at figuring out whether or not code does things and machines understand, and autograders for computer science are not very good at evaluating things like, How well is this code designed for collaboration amongst people? How sensibly are the functions named? and other kinds of things like that.

My hunch is, we'll make progress on it. My other hunch is that it will remain a pretty hard problem for a pretty long time. And also, it's a problem we'll solve in degrees. Will we give better automatic-- five years from now, will we give better automatic feedback to the typical middle school essay written in almost any topic, and will some of that feedback actually be useful? It seems almost certain to me.

Will we be able to actually grade? Will we be able to actually say something like, this paper is better than this other paper, with all the consequences that are attendant to that? We already do that to some extent in the education system, but I think we're still going to find that we're not confident in the assessment that these machines make. But fortunately, these are all testable hypotheses. So if your predictions were more optimistic than mine, you could very well be right.

Let's talk about massive open online courses for a bit. MOOCs burst on the scene in particular 2011, 2012. So almost 15 years ago now. How many of you have taken a massive open online course? How many of you have signed up for a class? How many of you signed up for one and finished it all the way through?

OK. So people laugh because that is a much smaller number of folks. This is one of the distinctive features of online learning, is that online learning is really hard. If you were not alive or paying attention to education in 2011, 2012, 2013, it is hard to understand how much people assumed that these tools would completely change higher education. Not be a little bit useful maybe, but utterly rearrange educational systems.

People thought there was going to be before MOOCs and after MOOCs. Part of the hype of this, the first really large-scale class like this, Sebastian Thrun and Peter Norvig, who are computer science-- Sebastian Thrun works on self-driving cars. He founded a company called Udacity. Peter Norvig worked at Google forever. They were both professors at Stanford.

They created a class called Intro to AI. And they sent an email around to the IEEE mailing list saying, anybody want to take this Intro to AI class? They were particularly inspired by Sal Khan. I think it was-- who was talking about the MITx practice sets that you were going through? They were very taken by that model. You watch a little bit of a video, you solve a couple of problems, you watch a little bit more video, you solve a couple of problems, interleave them along.

They send this email around. They're thinking, maybe a few hundred, maybe a few thousand people show up. 100,000 people sign up for this course. 100,000 people, multiples more than Peter and Sebastian combined would have ever taught on Stanford campus in their entire career there. And there was a vision like, wow, this could happen for everything everywhere. This could be all of higher education in the future.

The amount of resources that ultimately people like Peter and Sebastian could put behind a course for 100,000 people, you could easily spend $100,000 building that course material, and then the cost of every marginal student, every additional student would be quite low. So most people who are teaching a class, you hire someone. You pay them $60,000 a year in a community college, maybe less. You pay them $100,000 a year at an elite college, maybe a little more. And they spend some of that money making a course, and 20 people take it, and that's that.

But imagine if you could concentrate resources to make the best possible instructional sequence, the best course ever. I did my undergraduate at the University of Virginia. And the University of Virginia very briefly fired their president in, I think, 2013, because she was not transitioning fast enough to this new online world. And then the Board of Governors underestimated her popularity on campus, and all the faculty and students came out on the lawn and protested, and she got rehired.

But imagine if MIT's president, UMass' president got fired this week because they weren't moving fast enough on AI. That was the equivalent of what was happening in 2013. It was just madness. And I had just finished my PhD, so I had just finished at Harvard in 2012. I spent a year working at an organization nearby called Facing History & Ourselves, and I got hired at Harvard as the first researcher whose responsibility was to create a research infrastructure for HarvardX.

There were three big bets, that when Harvard and MIT came together to create MOOCs, to create edX-- MOOCs had been created in other places, too. Coursera at Stanford, most notably-- there were three things that they're going to try to do. They're going to provide new pathways into higher education for people who had limited access, that basically there are lots of places in the world where people can't get into higher education because they can't afford it, because it's not nearby, the programs they want aren't there.

If all of that is online, then as soon as you can connect people to the internet, everybody can participate in everything. People thought that it would reorganize, disrupt, unbundle, profoundly change systems of higher education. So universities might still be around, but they could be organized in totally new ways.

We were talking just at the beginning about how research universities often hire people who are not particularly good at teaching. Well, what if all the teaching just got provided by these companies that specialized in generating learning materials, and then your research professors could just go do their research and all of you could take 6.001 from an online course?

AUDIENCE: Wasn't there a quote from the book that was like, in 30 years, there would only be 10 universities left in the country?

JUSTIN REICH: And Udacity could be one of them. Yeah, yeah, that was Sebastian Thrun. And the idea probably from that-- it was probably not quite as crazy as it seemed. It was probably not that there would not be institutions of higher education, but you would go to UMass or Bunker Hill Community College and all of the classes being taught there would have been made at Tsinghua University, Stanford, Harvard, MIT, CMU, and a handful of other places, Udacity and a handful of other places.

And going to something like UMass or Bunker Hill Community College would mean taking online courses that were created by elite institutions elsewhere. And you'd get a dorm room, and be in a fraternity, and be able to have a human do recitations and extra help and things like that.

But people really-- it sounds ridiculous, but people absolutely believed that. People thought, for sure, that higher education would be-- if we went back into 2012 and said that higher education is basically the same, except having more financial difficulties, in 2024 than it was in 2012, there would be lots of people who would be very surprised by that.

So I guess this presentation-- I don't know when I developed this, probably 2019 or something like that, but it was at the moment where it was pretty clear that none of these bets were going to pan out, that we were not going to accomplish these things. And I was trying to help a community-- I don't know, sometimes you'd be talking-- like the people we talked to last time, education deans and stuff like that, or provosts or funders or people educated in education, why didn't MOOCs do the things that we wanted them to do?

Oh, first of all-- actually, I don't have to spend too much time on it because it sounds like everybody has taken a MOOC. But the most important thing that you need-- the two most important buttons in a MOOC are the Previous button and the Next button. That's kind of what makes it instructor-guided learning at scale.

There's a bunch of stuff that we shove in the middle. And then you click Next, you do some stuff. If you get it wrong or get confused, you click Previous, but you linearly make your way through some instructor-guided set of materials. A bunch of it is video or animations or text explanation or stuff like that. And then periodically there are some assessment questions that come along. We realized, as education researchers, almost right away that folks who are furthest from opportunity were not the ones who are signing up for MOOCs first.

This is a paper that was published in 2019 in *Nature* by Ezekiel Emanuel, who's actually mostly a medical researcher. But he was like, in the United States, here's the population with a college degree. Here's the MOOC student population with a college degree. In Brazil, Russia, India, China, South Africa, here's the population with a college degree. Here's the percent of people from those countries taking MOOCs who have a college degree.

So basically, we could tell almost right away that the people that we were recruiting into MOOCs were folks who were already educated. Today, I don't know that we know everything about why that's the case. People who have earned an education probably enjoy education as leisure time activities more than people who don't pursue an education. That would be normal.

But I would say that one thing that we've discovered in various formats is that online, self-paced learning is incredibly difficult for people. You all laughingly joked about that when I said, how many of you have started a MOOC that you didn't finish? And you all are some of the best people in the world at self-paced learning. And you found it hard.

The entire population, the vast majority of people find online self-paced learning really, really difficult. They have other priorities in their life. It's boring. And actually, an interesting thing about people is that when they're studying something they really care about, they can be quite persistent in learning. So you study young people who are like-- right now, if you ask young tweens/teens to explore skincare routines online, they will pursue that with great passion, great determination, persist through lots of difficulties, and be successful.

They will not do the same with algebra. You kind of wish as a society that they were better doing it in algebra than skincare routines, but that's just not the way human beings seem to be wired. So who gets good at online self-paced learning? How do you become good at being a good autodidact?

I think the best guess we have is that you get an apprenticeship in the formal education system. The best way to be good at learning on your own is to learn with a bunch of other people. So that means the way to become really good at taking these online, self-paced MOOCs is to go get a college degree. But if your goal was to create new pathways into higher education for limited access, building a thing which you really have to have spent a lot of time in education to be good at is maybe not the best strategy. But people didn't know that at the time.

This is an article that I wrote with Mariano's advisor, José, where we were trying to figure out why MOOCs were not working. And one of the things that we observed-- these are charts of enrollment, but they're charts of enrollment by human development index categories. So basically, way more people were coming from the world's most affluent countries than were coming from the world's least affluent countries.

And we basically made no dent in it over the first eight years or so. You could imagine, oh, well, we started with a pretty big gap. If these three lines in the bottom had continued to traverse up, then maybe you could say, OK, we're making progress towards our goals. The other thing that was kind of a problem is, heading into the pandemic, enrollments and if you're trying to run a company or something like that, it's really not good to have this line go down.

You'd really like it-- if this was Facebook's graph, it would just keep going up exponentially forever. That was another problem with MOOCs compared to other social media businesses. When you sign up for Facebook or Twitter or something like that, you're kind of stuck in there forever. When you sign up for a class, the class ends, and then you leave and go do something else with your life. So why didn't this work? Or actually, we'll talk about the second one next. But what were you going to say, Maria?

AUDIENCE: I was just reflecting. One thing that I realized as well recently is that everyone now creates their own course. Every influencer has a course on something different, right? And I think that probably also affected this ability of MOOCs to spread because, originally, five or six organizations were creating content. And nowadays, this is very decentralized. So even if it's still hard for people to complete these courses online, et cetera, et cetera, there's also a lot more competition, right?

JUSTIN REICH: There's a lot of competition out there. And traditional institutions prove to be very effective in that competition. So here's the thing which shocked even me. At the beginning of the pandemic-- you all remember this from March 2020, April 2020-- we sent you all home. And here's something that could have happened.

There were thousands of professors in the United States who were teaching Introduction to Microeconomics. And a bunch of them could have said, there is no way I can do a good job continuing to teach you Introduction to Economics. My kids aren't in school, they're running underneath my feet right now. I've never taught online before. Just go to edX, go to Johns Hopkins, go to MIT, take their courses, and I'll give you a test at the end and help you out.

The alternative is that, I take my lectures, I put them online, and we meet in Zoom once a week. And I still keep giving you your lectures. Basically every learner and institution in the world preferred the latter option. All throughout the pandemic, at all levels of the education around the world, we basically said, would you rather have this really high production value class kind of offered anonymously from some institution that maybe you've heard of but you have no connection or with your own harried professor, who's taking care of his kids while teaching you, who doesn't know anything about online learning? And people overwhelmingly picked the latter.

I don't know why. I don't know why, we don't know why they picked the latter, other than the fact that education is a profoundly social enterprise. Even the comment you made about influencers having their own courses and things like that, you have a parasocial relationship with those influencers in a way that you wouldn't from Josh Angrist, who teaches the economics class here or something like that.

All right. Let me try to say two more things before we head out. Oh, well, some of these things are on there. The main advantage that MOOCs have is they reduce faculty labor. They pull faculty out of the equation. They just make them television stars instead of teachers. And there's basically no way to do the economics of MOOCs, except to dramatically reduce human contact.

But what helps people learn is human contact. The way that you persist in most of your learning environments, especially when you're learning something you don't care about and are not that interested in, is you care what your faculty thinks about it. You care where your peers are. You have all these other human things that keep you connected.

And because of that, most people are not good at self-regulated learning. If the vast majority of people are not good at self-regulated learning, if the only way to get better at self-regulated learning is to go through the K-12 system and go to college, then this is not going to be a good system for helping folks further from opportunity get into college.

The primary way that MOOCs were going to disrupt higher education is-- there was a very, for me, influential article that said, the actual innovation-- nothing was innovative in MOOCs. A learning management system is not new. edX was not new. Coursera was not new. Canvas was doing the same thing. Moodle was doing the same thing. Blackboard was doing the same thing.

Autograders are not new. We had all kinds of autograders and all kinds of systems, that the actual innovation in MOOCs was putting a storefront on top of a learning management system, that the thing that was actually different was that, in the past, if you wanted to buy a Harvard course, you had to buy eight a year, and you had to rent an apartment, and you had to buy all your meals from the institution.

You had to buy this giant bundle of stuff. And so the bet that Harvard, MIT, Stanford, other folks made is, what if we sold just one course at a time? What if you could come in and just take one Intro to CS class, one Introduction to Economics class. And millions of people were interested in that.

I mean, the number of sign-ups that appeared in many of these courses were these astronomically large numbers. CS50 at Harvard had millions of people enrolled with just a couple of years. A tiny, tiny fraction of them finish. Something like 1% of them finish. On average, MOOCs, about 5% of people who register, about 10% of people who click into a course once will persist in a class. But pretty small numbers.

However, it turned out that storefronts didn't solve all of the problems that universities stored. So people were excited to try out storefronts. But storefronts by themselves didn't confer legitimacy. Really traditional things like registrar offices confirmed legitimacy. Things that publish transcripts and degrees and diplomas confer legitimacy.

And so this idea that MOOCs could move forward just by selling one course at a time proved untrue. So then MOOCs did something which was surprising to people, which they said, well, all right, why don't we start offering whole degree programs? How about instead of taking just one MOOC at a time, you'll take eight MOOCs and get an MBA? You'll take eight MOOCs and get a data science degree, a computer science degree, or something like that.

There were companies that had been doing that for a long time. Those companies were called Online Program Managers. They are some of the most unreputable companies in the higher education space, for a few reasons. One is, they tended to be pretty secretive. So you would sign up for an online degree from an organization, and you think you're getting this degree from the University of Chicago, but you slowly realize that there's a company called 2U or MBANet or Pearson MBANet services or something like that, which is actually providing a bunch of your educational experiences.

The Wall Street Journal, in the last couple of years, has had a bunch of exposés of boot camps that are branded by state universities, but they're actually just run by a company. It's called the Oregon Computer Science Boot Camp or whatever, Computer Programming Bootcamp, but nobody who teaches in it works for the University of Oregon, things like that.

I mean, the other problem that universities faced was that a key precept of businesses is that you do not outsource your core competencies. So if you're a university and you outsource your janitorial services, that is a great idea. If you outsource your accounting services, that is a great idea. If you outsource your teaching and learning, that is a bad idea. The teaching and learning is the thing that you do as a university.

So I don't know. I wrote this paper in 2019, which said something like, man, these massive open online courses, they sure seem to be behaving like Online Program Managers. They're partnering with these organizations. Part of the ways that they were compelling to organizations is that they would go to a university and say, we will pay up front for the development of these degree programs. But then, for the next 15 years, we'll take 40%, 50%, 60% of all the tuition revenue that comes in.

In year one, that might seem like a good idea because you didn't spend any money and you got this new tuition revenue. But 10 years from now, you're like, why am I paying 2U, Coursera, edX, 60%, 50%, 40% of all the tuition revenue that's coming in when what they're doing is, in some respects, not that hard. They're running a learning management system and doing some online learning. We can figure out how to do those things.

This was a bit of a controversial paper when I published it, and there was a whole bunch of people who said, come on, Justin, that's really not fair. You can't say that MOOCs are turning into Online Program Managers. But then two years later, 2U, who was the largest Online Program Manager, bought edX. And even that was a convergence that I wouldn't have projected.

So I know some of you may know that all of the proceeds from the sale of edX went to this nonprofit controlled by Harvard and MIT, called Axim. So 2U paid $800 million for edX. And that $800 million went to start a new nonprofit.

Headlines like this were kind of funny to me. "Harvard and MIT-led nonprofit to tackle longstanding inequities in education." But that's exactly what edX was. edX was a nonprofit designed to tackle inequities in education. It was like, well, that didn't work, so we're starting a new one.

I just like how the big headline is like, this is this brand new thing that we're doing. And by the way, it's because we sold the last version of this that we just did. Tiny font at the bottom. This was last year's sales price for edX-- or for 2U. And yeah, their stock has declined 90% over the last five years.

You can see the pandemic bubble here. People did a bunch of online learning. And then partly they were less enthusiastic about it. But also, as universities get better at offering online learning, they don't have to partner with groups like 2U anymore. This is actually today's stock quote, where it is down 99.36% over the last five years. So 2U paid for edX substantially more than the entire company of 2U is currently worth today.

AUDIENCE: I guess I was just looking for clarification on edX and MITx and HarvardX. Is that all the same thing, like the MITx that we use now?

JUSTIN REICH: No. Well, all right. So Harvard and MIT each put $30 million. They create units called HarvardX and MITx. Those are independent brands. The shared infrastructure that those things used was this thing called edX.

edX was a company. It also created an open source learning management system called Open edX. So the nonprofit edX was sold to 2U to become part of a company. But there still is an open source project called edX, which is a learning management system software. MITx, and if there's still a thing called HarvardX, to some extent in their products, use this thing called Open edX. That's what they're doing.

AUDIENCE: The infrastructure at MIT. The content that we look at when we go on MITx as students is not owned by this company.

JUSTIN REICH: Yes, although it's slightly more complicated than that because I think they definitely bought the rights to display all or most of them. Maybe they could display anything that they had instructors' permission to be able to display. I took all of my courses off of edX when it was bought by 2U, because I don't want to support Online Program Managers. I don't think they're good for higher education. Some departments did that, things like that. They still might have some rights to display some of it, but they still basically did what they wanted.

AUDIENCE: Because if you look at it, a lot of it-- and even OpenCourseWare is also from 2008. It hasn't been updated in many years, which I guess makes sense.

JUSTIN REICH: Yeah. And in some ways, in theory, a lot of the argument is that it shouldn't have to be. How much did multivariable calculus change since 2008? Not that much. And part of the way that you gain the economy of scale is by leaving these things alone.

All right. We'll come back, and I'll finish this in here, except to say that we tried a whole lot of stuff to develop a new science of learning. And probably the main thing that we learned is that people who click a lot into things do better than people who click less into things, which you probably didn't need a $60 million investment to be able to figure out.

But I'll finish with this next time. You'll turn in your papers by email, and we'll talk a little bit more about intelligent tutors as well, both on Wednesday and the following Monday. If I can help you at all with paper one or anything else, let me know. Otherwise, have a wonderful rest of your week.