MODERATOR: Allow me to give you some information about Dr. Rose. Dr. Rose is founder and chief education officer of the Center for Applied Special Technology, CAST. CAST was founded with a vision of expanding opportunities for students with disabilities through the innovative development and application of technology. Dr. Rose specializes in developmental neuropsychology and in the universal design of learning technologies.

Dr. Rose also lectures at Harvard Graduate School of Education and is the co-author or editor of the books *Teaching Every Student in the Digital Age: Universal Design for Learning*, *Learning to Read in the Computer Age: A Practical Reader in Universal Design for Learning*, *The Universally Designed Classroom: Accessible Curriculum and Digital Technologies*. Please welcome Dr. David Rose, who came from a Boston storm.

DR. ROSE: Thank you. Thank you. Good morning, everyone. It's a pleasure to be here, and, well, and nothing. I'm going to start. I'm going to talk about Universal Design for Learning, and I, there's a number of parts to the talk. I'll try to stop midway through for a few questions, and I'll try to stop a little bit early so that people who are tired of a long conference can get a little break, and I can answer some more questions.

I want to start, though, with just a sense of, is this at all important? I know you've had lots of things come across your desks, lots of new ideas, and is Universal Design for Learning worth a, you know, an hour and a half of your time is a good question. So I'll just, I'm not going to do too much of this, but I wanted to read a letter, recent letter from Secretary Duncan to Congress.

This is around the National Educational Technology Plan and not something about disability or anything, just the new technology plan that was just released in November. And the first parts, you know, are boring and stuff. And then we get to the middle part where I was struck, didn't know this was coming. But it's, the point of the new tech plan is, it's supposed to be focused not on technology but on learning itself.

And there was a good deal of effort to try to get a lot of cognitive scientists and so on as part of the plan as well as teachers and educators of various kinds and not to have it be dominated by technology people, which I thought was a good thing. The model of learning described in this plan calls for engaging and empowering personalized learning experiences for learners of all ages.

The model stipulates that we focus what and how we teach to match what people need to know and how they learn. It calls for using state-of-the-art technology and Universal Design for Learning, UDL, concepts to enable, motivate, and inspire all students to achieve regardless of background, languages, or disabilities. So he didn't check with us about writing this. I thought it was pretty nice, though, a nice statement.

And I think, as we'll talk at the end of this talk, UDL's being increasingly put into national policy documents, and the early draft of ESEA, for example, has a lot of UDL language in it. And so one of the concerns that, I've had breakfast with some folks from here already, and I know one of the concerns everybody has is how is this going to be put on the top of everything else I have to do?

So mainly I want to talk about how it fits within things that you have to do, and I hope that it eventually makes things perhaps not easier but better but, in any case, not another add-on. So it's, the nice part is, to start with Duncan's recommendation to Congress, is he's saying UDL is a natural part of the National Technology Plan. It's not something extra.

It's not like assistive technology, oh, now we need another plan for assistive technology. It's building UDL directly into what's our future Educational Technology Plan, which is a good step. The Higher Education Act, that just is another example that came out in 2008, for the first time in congressional language defines Universal Design for Learning.

The term Universal Design for Learning means a scientifically valid framework for guiding educational practice that, A, provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged, and, B, reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English-proficient.

So that's the official congressional definition of UDL, and that is already, I know, part of the drafts of the Elementary and Secondary Act going forward. I want to start with one, just a little bit older piece of policy as a way to start my actual remarks, and this is the National Instructional Materials Accessibility Standard. And I want to argue that there's something incredibly pivotal in this piece of legislation, which isn't what most of it's really about.

So NIMAS, I'm going to call it NIMAS, came out in 2008, the regulations for it, and I want to indicate that there's something embedded in it that I think is really important, and I want to highlight that for you. So what is the National Instructional Materials Accessibility Standard? NIMAS is a standard for digital source files that can be used accurately and reliably produce instructional materials in a variety of alternate formats using the same source file.

Now most of you don't care about that. Okay? That just says that when publishers make a new textbook, they're going to make it in some kind of source file, and we're defining what that is saying make it this way. Make one great perfect source file. And from that, schools, teachers, and so on can make many different versions for their students.

One underlying source file done right, as long as it's a digital source file in the way that we've told them to mark it up, then we can make many things from it. And that law passed, and there's a NIMAS standard. So publishers are all now publishing with a single source file called the NIMAS source file. I'll talk about what that means for you in a moment, but that's what the law looks it about. Why is it, why is there this law?

It addresses the national need to increase the availability and timely delivery of print instructional materials in accessible formats to blind or other students with print disabilities in elementary and secondary schools. Now that little part I've put in yellow here, print disabilities, is the first time that word, those two words, have been ever in public legislation. And, in fact, most of you, in fact, most people anywhere never heard the term print disabilities.

Its appearance here is actually what I think is the little time bomb within the law that's very powerful. So I want to just, sorry, let me just do one more slide, and then I want to come back to that little time bomb. What's the outcome of NIMAS? Virtually every textbook in American schools published after 2006 is now available in this digital XML version to any child with a print disability. In fact, they get it free.

So any child with a print disability can have one of the alternate versions made from your textbook, and every publisher is making these digital source files. So this is to get around the problem of everybody having to figure out, oh, how do I get a Braille version, how do I get a talking book, how do I get a book that's large print, all of those things. All of that will be made much more easy now for a child with a print disability. So the key is, who has a print disability?

And what I want to just have you, it's too big to have everybody talk to me, unfortunately, but I'd like to just take one minute for you to talk to your neighbor, because, for me, the little time bomb in here is the big difference between a learning disability and a print disability. Okay? So just take one minute and talk about why I would think that's so important, saying a kid has a print disability versus saying they have a learning disability. Talk a moment, will you?

Just talk about that. Don't talk about the Bears' football game. So I hope that means you had thoughts. Does anyone feel like they could shout out for me what's the big deal about thinking about the difference between print disability and learning disability? Does anybody feel like they have, yes, there's somebody. Can you shout out as loud as you can?

WOMAN: What the difference is?

DR. ROSE: Yeah.

WOMAN: I think the difference is, is that a print disability is if you give them an alternative, they will be able to learn. What a regular disability is, if you give them a print alternative, they're still going to need other services.

DR. ROSE: Okay. The difference is that with a print disability, it means that the printed book is part of the problem. If you don't have that, then you don't have the disability. And that's very close to the way I think of it. Does anybody have a different they wanted to say or say something different than that radically? Okay. It's such a big group.

The real, that you, I think, have captured it, the special thing that's happening, which is the beginning of a lot of laws like this, is that for the first time, it's defining disability in terms of the context, not just the child. When we say the child has a learning disability, it means the problem is located in the child. When we say a child has a print disability, it means the problem lies in the interaction between the child and print.

So print is part of the problem. Okay? It's a little bit more like allergies in that regard. I have allergies. They're partly me, but they're partly the environment as well. I do really well unless you put me in a dusty room and so on. So print is part of the disability. That is a big change. Okay?

And today I want to talk about what I think the future is in thinking this way, that is, starting to realize that our instructional materials and methods may be the source of the disability and that it's better, often, to think that way than to start to think about the child as the problem. Okay?

And I think print disability is a watershed that has been made possible by three different advances that I'm going to talk about today, advances in our understanding of the brain and learning. That is, we wouldn't have come to the idea of print disabilities if we didn't know some things about learning that we didn't used to know.

And I'm going to talk a little bit, my background's in neuroscience, and I want to talk about what we've learned recently about the way the brain actually learns. And some of those things are key to rethinking what disability means. Secondly, we've had some big advances in our understanding of print, because there's new media.

There used to be only print, and when you have only print, then you can, unfortunately, not actually pay good attention to what is a good ad and what is a bad ad. But now that we have, I've got my little iPad here, which I love having, that the more you have an iPad, the more you start to go, whoa, how come I can't do this in print? And print takes on a different posture. You begin to look at print and say, what's it good for, what's it not good for?

So I still like to read books, but there are some things I would never read in print anymore. I would want to use it on my iPad because of the other things I can do. So we've had advances in our understanding of what print is, primarily because there's new media now, there's alternatives, and, lastly, advances in our understanding of disability and ability itself and, in particular, what we mean by universal, which I want to come back to.

So I'm going to have three parts to my talk. I'm going to talk about what we know about learning from the neurosciences, what we know about new media versus print, and, particularly, how do we design in new media that has affordances that we never had when we had print alone, and, lastly, advances in our understanding of what universal really means, and what is disability and what is ability?

And I think you can see that the term print disability is at the center of this in the sense that it begins to redefine disability significantly, and it depends on a view of technology that's different and so on. Okay? What do we mean by learning, first of these three parts? So I want to talk about neuroscience a bit.

And there's been, as I think everybody here knows, an absolute revolution over the last 10 to 15 years primarily because of new technologies that allow us to see things we could never see. When I was a, I used to be a neuropsychologist, saw kids in hospitals who had neurological problems, did school evals for them, and we didn't have any way to see what was going on inside their brains.

All of the stuff that you are now familiar with, FMRI, PET scans, etc., none of that was available. So we had to go entirely on external neurological signs, which now it just seems so hopeless, seems so stupid. And now we have these gorgeous images.

So we've learned a lot, and I want to say, by the way, that it's the same technologies that have allowed us to look at the brain that are the same technologies we need to take advantage of in our schools from where we work with kids' brains. So just to have you come with me just a little bit, this is an image here. These are called

PET scans. It's one of the new imaging devices. And I want to highlight what they're doing.

So a PET scan is measuring the amount of glucose that's being burned, sugar. So when neurons, when your neurons fire, it takes energy, so they have to uptake some more oxygen and some more glucose to keep firing. So what PET scans do and the other imaging devices are measuring oxygen and glucose being metabolized. And they're looking for where is it hottest? Where is the most action?

So you can see where it looks hot, like white hot is where it's really hot and red hot less so and yellow hot less so, and it's dark. Okay? So you can see that there are some areas here that are burning very bright. They're literally burning glucose and oxygen. Neurons are firing like crazy there. Is everybody with me so far? Okay.

And you can see that when you hear words on the left side of the screen, you light up, as images say, different parts of your brain than when you see them. All right? There's no surprise there. In the seeing, you're using what we know to be visual cortex. When you're hearing words, you're using largely auditory cortex. So different parts of your brain light up burning glucose and oxygen.

But the really powerful stuff came when the neuroscientists left the machines on a little bit and watched what happens when people learn things. This didn't happen right at first, but this is also something extraordinary. You didn't just get a snapshot, you could actually watch. Well, what happens if somebody can't do something, and you teach them how to do it, and then they can?

What changes in the brain? Now this is a fabulous set of, and I'm just going to show you a couple slides here, because, in my experience, and I was alive when all this was happening. Well, let me do the setup first. On the left, there's a naïve brain, that just means a college sophomore, doing a task. Okay? And I'll tell you what the task is later, but it's not important now. And that's the way the brain lit up, and that's called a signature.

So you can see sort of, oh, this task uses this part of the brain and not that part of the brain. Now the question is, after that college sophomore had a little practice doing this task, what would change? And, remember, nobody had seen anything like this before. The first time it was really extraordinary. So neurologists had, they had mixes like everybody else, but the sort of zeitgeist of the world was one way they thought it would happen but would change.

And they turned out to be wrong about what changed. And my experience is I ask educators what they think will happen, and if, I'm not usually talking to audiences quite this large, but usually the majority of educators, unlike the neurologists, guessed immediately what would happen. So what I'm going to do is a diagnostic here to see whether you should have been a neurologist or an educator. Okay?

If you get it right, you're in the right job. If you get it wrong, you should go to medical school. Okay. So think for a moment what would change when the person knows how to do the task very well from when they're naïve and are just starting. Okay? I want to just give you a pause for a moment so you really think about it, and you can talk for a second, although, boy, you're hard to quiet down, so don't get too excited.

It's a little bit too big a group to do this in, but there's commonly three hypotheses, and we'll see if you have these. One of them is that more of the brain

becomes involved, that learning is sort of aggregating your resources. So when you start, you're kind of localized, and you only, you know, you don't know how to use your brain. And as you get better and better, you use more and more of it. That's what learning is. Okay?

A second is, ah, I know what, I'll have a vote on this. A second is that learning is, in fact, getting more efficient at something, so whatever you started with you get so that it's more and more focused and uses less of the brain, because you're good at it. Okay? And that's what makes you efficient. And a third is that novices use parts of their brain, but experts actually use different parts. It's not more or less, it's different. Okay?

So those are the three hypotheses people usually have. Let me just see what people here think. This is the should you have been a neurologist check. How many people think that what happens is that more of the brain becomes involved, so you see a few areas here, and it becomes more of the brain, so it's more. How many people think that's the case? Only a few. Wow. That's cool. Okay. All of you should be neurologists.

That's what the neurologists thought would happen. Seems like, you know, makes sense. Second, the brain, it gets more efficient, so it takes less space and time and all of that to do something. How many think it's number two, that it becomes more efficient? Large majority. Okay. Let me just ask the last one. How many think it's like a different part completely lights up? Okay. Great. Actually, both of the second two, the second and third are both correct.

What happens is that definitely the brain uses, it's much more focused. You'll see the areas that light up get much more tightly focused, because you're good at it. But also there is some subtle shifts that happen between novices and experts that you actually start to see the task differently as an expert, and you actually start to use your brain differently, and that's no surprise to you.

Think of yourself, if you know music or bike riding or anything, you realize that at the beginning, you're really concentrating on very different things than when you're an expert. So actually both of those things happen. And I'll show you, here's the first findings they found that the practice brain looked like that. It was like, and they went, oh, my God, the person died. And, of course, they didn't.

But it was a surprise to them how, in fact, the efficiency was, what was, the brain was doing, it said, it doesn't take much energy for me to do that anymore. I'm easy at that. The novel one you see at the end is that they just changed the task a little bit, and what happened was the brain lit up again but not so much. But notice it lights up in the same areas.

And so it was, this is what you all were looking for is transfer of training, that if you teach them in one thing, and you change the task a little bit, you hope they'll better at even a new task. And that's what the brain did, too. So at the beginning, it burned a lot of glucose. When it got good at it, it was done burning glucose. And then if we change the task, it burns some but not as much. Everybody with me still? Okay.

And I call this the Vygotsky in the brain slide. The neurologists don't know anything about Vygotsky, but you do, so I wanted to say that our job as educators is to, obviously, not waste kids' time. We don't want to have them be bored where they're not learning anything.

That would be, because, in fact, what we've learned is that the glucose and the oxygen burning is the brain changing itself, and that's what we want kids to be doing, changing their brain from a brain that doesn't know how to do things to a brain that does know how to do things. And so we want to see that glucose burn. We want to see that they're changing their brains. But there are two times you don't change your brain.

One is you already know how to do it, which a lot of students in our classes are there, they already know how to do this, they're bored, or that the task is too hard for you. You actually can't change your brain enough to do this task. And that's what Vygotsky talks about, the zone of proximal development and that many kids are not in their zone of proximal development because the task is too hard.

So they can't burn glucose and change their brain, because they don't know what to do. All right? And so our job as educators, as Vygotsky would say, is to always be trying to keep within the child's zone of proximal development. It is just hard enough that they'll have to change their brains but not so hard that they won't change them and not so easy that they won't change them. So that's hard. The hard part isn't doing it.

The hard part is doing it with 25 kids at once, because the kids are all over the place, as you well know. How do we get 25 different kids at just the right level of hardness so we're not wasting their time, and we're not terrifying them? So that's the hard problem that educators have for sure and that UDL is meant to go after. How do we get more kids in their zone of proximal development just hard enough? Okay.

I want to do a little bit more on learning. You know what I'm just realizing? Does anyone have a pointer, little colored pointer? Both, I brought two clickers, this is showing technology at its worst, and both of them, it's not important, I can survive without it, but anyone have a . . .

WOMAN: Yes, we do.

DR. ROSE: If you just had a, then I won't have to walk around. I want to make a, two more points about what we've learned from the brain. First, that learning is really differentiated, meaning, just like in differentiating for students, there are many kinds of learning, that sort of the global view of learning is gone. Cognitive neuroscientists don't think about learning as being one thing anymore. They don't think about memory as being one thing.

They don't think about attention. Thank you so much. I do that?

WOMAN: . . .

DR. ROSE: Oh, you have to be, see, now you would have seen in my brain, as she was showing me the button, a big glucose burn as I'm going, can I learn this in front of 900 people? And now by the end of the talk, I won't be burning glucose at all, but I'm not sure that I can quite get there. Sorry, this one's maybe a little bit too puny for how, okay, so I'm going to, I'm going to, what's that? But I'm doing it right.

I want to be clear I'm doing it right. Okay. But I'll wander over there to get a little closer. So memory's not one thing. Attention's not one thing. The brain is much more diverse than that. I want to say, because it's absolutely true, the brain is much more like your classes than we used to think, that is, it's a highly diverse organ.

There's a lot of parts of it, and some of the parts in your brain work really well, and some of them don't work so well, but it doesn't make any sense to a cognitive neuroscientist to talk about learning in general. He's a good learner. It sort of doesn't make sense, because they'd want to say, well, what kind of learning are you talking about?

And there's all kinds of wonderful examples of people who can learn, and you've probably heard of these amnesiacs who can learn, can't learn, can't remember that they've ever seen you before. Holy cow. It's getting more and more, oh, there it's good. That's what I'm used to. It's working. I guess it's, oh, yeah, there. I see a little red thing. So you'll have to squint and see it. Thank you very much.

So let's talk about a little ways in which this brain is a differentiated learning mechanism. So here, and don't worry, we're not going to get too deep, but here's four brain slides, and what's interesting is all of these are a college sophomore doing language. But look how different they are. I realized I'm miked, so I can walk over here. This is passively viewing words, just looking at words. This one is listening to words. This one is generating verbs.

I'll explain what that means. And this one is speaking words, any word. So the task is very simple, and it's actually the first task I showed you, and, this one, sorry. And it just means that the student, I say a noun, and I ask them to say a verb. They can say any verb they want, but they must say a verb.

But what stunned the neuroscientists was look at the difference between say any word you want, and this is the way the brain lit up over here on the left, say only a verb when I say a noun, and this is the way the brain lit up. It turns out to be really different. And they went, wow, well, that's so different.

Now we know that verbs aren't treated the same as nouns in the brain, but nobody knew that at the beginning, and the task demands you stay within a category, and that requires a different part of your brain to know how to stay in a category.

So the brain lit up very differently, but it started to teach us that we needed to get a lot more smart about what the brain's really doing and that even something like language is not one thing, just like I said, memory, attention, none of these things.

Memory requires all sorts of parts of the brain, and by doing this, we started to realize all sorts of things about language and that it wasn't one thing, and there wasn't any way to say a kid is language disabled to a brain scientist. They'd go, well, what part of language are you talking about? Because this really doesn't, wouldn't make any sense. By the way, it's going to be very interesting in the light of Congresswoman Gifford.

Everybody's, of course, really interested in what kind of recovery she's going to have. We have no idea right now, but she'll make splits in things. She'll be able to do some things perfectly well and other things not at all. And it's going to look much more like this. And some of them will be odd to you. She may just be able to actually hear and understand every piece of language and not speak, and all kinds of things can happen. Okay.

So it's differentiated even within something like language. There's many parts to language and, as it turns out, many things you need to learn about language, and you learn them somewhat differently in these different parts of your brain. Here's music. I

just want to check my time. I think I'm going to go rapidly through this, but this slide, when you listen to music, it isn't like you have a music center in your brain.

In fact, these are parts that are lighting up here. Down at the bottom, the temporal lobes are lighting up to the harmony. You listen to the harmony with this part of your brain. The melody is up here. Different parts of the brain are lighting up. And the rhythm is down here in the cerebellum. So when you're listening to music, you actually are bringing together a bunch of separate processors, and you're kind of making a committee.

And I know some of you have been on some very dysfunctional committees. But picture you're on a really well-functioning committee, and you say, all right, you do the invitations, you do the cleanup, you do the whatever. So your brain says, you do the rhythm, you do the melody, I'll take care of the harmony. Okay? And that we have that kind of differentiation.

Later I want to talk about some differences between myself and my wife, and I have, after decades of music experience, I can do some of this and not others. Okay? I just want you to feel okay about my disability. Reading, many studies have been done of reading. And reading, in fact, has many, all these little dots are parts of the brain that lit up when students were reading single words. Look how many parts of the brain get engaged in reading single words.

And this should belie the kind of notion that it's sort of like maybe there's a place in the brain you do reading, or reading is a single skill or something. Reading is a very complicated thing that you do. You have to marshal a very large committee, one of the largest committees imaginable, to do reading with. And each of them has to do their part well, each of the parts of the committee. So all of these are part of the committee, all of those dots, all over the brain.

And I'm going to kind of group things a little bit for you, and this is going to lead us to the principles of UDL. It's not aimless here. But I want to divide up the brain, as lots of people have done, into sort of three major things your brain does. Each of them are different kind of learning, a different kind of performance, and each of them are involved in most of the things you do as a teacher, although you emphasize parts quite differently.

So I'm going to talk about the things in the back of your brain called recognition networks, the things in the front of your brain called strategic networks, and the things in the middle of your brain called affective networks. So the first, recognition networks. These are the parts of your brain, they're in the, the wonderful thing is that things are more regular than at first it seems.

If it's in the back of your brain, from about the middle back, if I'm facing the same way that image is, that's where information comes into your nervous system, oddly enough, everywhere you look in the nervous system. If it's in the spinal cord, the mid-brain, cortex, information coming in, comes in the back. So if you have an injury just to the back of your spinal cord, you'll lose the ability to take information in.

You won't be able to sense things, but you still could move. Okay? So information in comes into the back. And what I have here is it takes a lot of cortex, half of your cortex, all of it's done in yellow here, takes that information from your senses, your eyes, your ears, your nose, your throat, and turns it into usable knowledge. Okay? Because just as sensations, it's not worth much to you.

What you've got to do is not sense the colors of the Buick but that it's a Buick, and that's a different thing than a hamburger or a bicycle. Okay? And usable knowledge is that, oh, I see it's a Buick. I know what to do with a Buick. And but you're going to take sensory information in and make sense of it, usable knowledge. I'm going to have you look at this picture three times.

This time as you look at it, it's the first time you've seen it, the back part of your cortex is lighting up as you try to recognize it. What is this? Okay? And your brain is fabulous. It does a lot of things that I spend four weeks talking about in an educational neuroscience class, so I'm not going to do all of that here, luckily for you. But I'll highlight some of the things we know about, how it can take that information in and make usable knowledge.

One is, and it's very important for schooling, is how important and how context works in the brain . . . another thing that we were wrong about. So if I show you that, you're not sure what it is, right? And you can work at it, but it's really, you're not sure. If I provide some context, you're same image is immediately clear to you. Now what's really interesting is that it's faster and better for you to recognize something with context than without.

Now that goes to the same probably the way the neurologist saw the brain, because you could think, well, all of that, a lot of stuff would be distracting to a kid. Let's make it simple. Let's make it just the thing itself. But actually our brains aren't like that. They're fabulous context processors, and it doesn't hurt to have context. It actually helps enormously.

And you may have heard of experiments that show that you're faster at recognizing, if you're supposed to recognize a B, you're faster at recognizing a B when it's embedded in a word than when it's all by itself. Can you imagine that? Just think about that. It doesn't make sense to some views of the way the brain works. So if you have just a one figure, it should be fast to recognize one versus four or five.

But, in fact, it's easier to recognize there's a B there in a whole word, that is, we show you something really fast. And it's because you bring context, and context is a powerful thing in education. Now a lot of the things we do in education, unfortunately, take things out of context. We say, we'll make this easier by presenting it all by itself, and I'm just going to . . . all sorts of things. Actually, the brain isn't a limited capacity processor in that way. Context is good.

And you remember yourself, you remember things in context. And I just realized, I'm going to make an anecdote of this, because it's a teacher anecdote. You can all remember the time that you ran into someone like your teacher in a grocery store, and you have no idea who it is for a minute. You just know, I know that person, but I have no idea who it is. And I've had, you know, we've all had it happen . . . in our lives.

You just have that feeling of knowing, which is another part of your brain that just takes care of, do you think you know this or not? Anyway, what's going on there? What's going on there is your brain's context processing is saying grocery store. Teachers don't live and teach in grocery stores. They're not there.

So it actually makes it harder to recognize your teacher in a grocery store, whereas if you put her in a classroom, it's like so easy it's amazing, okay, because the context goes with it. We have brains that pick up context. So placing someone out of

context actually makes it very hard to recognize them. That's why on the street, you'll take longer. You'll go, I know I know them. Okay?

When they're sitting across the table from you at breakfast, you go, I know I know you, because you're in my house. Okay. And the reality is that we not only know what we see, that is, it's not things that come into our brains, but we actually see what we know, that we bring, to make usable knowledge, we take all of our background information and use it to see new things. So what's that mean?

It unfortunately means that people who have a lot of background knowledge see more than people who don't have very much background knowledge in it. So it's not just that something that happens in your eyes, it's something your brain constructs. It says, okay, given everything I know so far, I think that's a lion, even if I don't have much information. So knowing a lot helps you see even literally new things. Second part of the brain.

I'll try to make this funny later. Okay? We're just going to kind of go through it quick. Second part of your brain is the front part. The front part of your brain does a very different thing, learns different things. And the front part of your brain is not connected to your sensory organs, not what you see here, and so on. The front part of your brain is connected to your muscles, to the ways in which you act.

And I have up here on the slide, the front part of your brain, the strategic networks, they allow you to plan, organize, and initiate purposeful actions on the environment. That is, this part of the brain allows you to be a strategic, skillful, actor in the world. And it's really interesting, because sometimes we forget we're so good at it. So let me just give you a sense of it.

When I show you this picture again, the very first time, you actually created a strategy in the front half of your brain for how you'd look at the picture. And let me show you what it looks like. These are eye movement tracks done with a camera, which look at an individual who's looking at this picture. Okay? Look how different they are. And let me just show one more. All of these are the eye track patterns for the same exact picture.

Look how different. Wildly different eye tracks, same picture. What's going on here? Two things could be going on, individual differences. And, in fact, now people have done studies to show that artists, for example, look at images very differently. They're very skillful lookers, better than you are. They know how to look at an image. And you look kind of amateurish, to be honest. Okay?

But this is, in fact, the same person looking at this picture seven times. So what's happened? And the answer is that a different question was asked. But within a half second, when I say to you, how are these people related, the front part of your brain starts to make a plan very quickly for how you'd look at this picture, and it would be one of these. You just go right to the faces, say I know where to look.

And that, people are now able to study it and watch it happen how fabulous it is. Here's, I'm sorry, this is a good one for looking at the, you know, how are these people related? The, just to give you an alternate, I can't remember the exact question, but it's the equivalent of, this one down here, it's the equivalent of saying, is there a cat in the room? And it's like, oh, my God, it could be anywhere. I've got to look all over. Okay?

So we make, we have this ability with the front part of our brain to be very strategic in how we even look at things. And if we make damage in the very front of the

brain, then we'll have what are called executive function deficits. And I know that word's becoming more popular, and probably most of you have heard those words now. And the person doesn't make a plan for how to look at the picture. So this is the person doing that task.

And four different questions were asked, and you can see that, in fact, they look at the picture the same way each time. They are not driven by a strategy. They don't have a strategy. And you probably know this to get to points we'll get to later. Young children, these parts of their brains aren't mature yet, and they seem not very strategic.

And kids who have ADHD seem incredibly non-strategic, because they seem to be drawn by the environment, as this person is, rather than by their plans. Okay? We'll come back to things like that. I think I'll skip these. We've done studies at CAST of watching kids look at textbooks. And what's interesting is a lot of the kids that you have, kids who have a variety of learning issues, this is, allows us to see 30 times a second, what are they looking at?

And if you follow their pattern, you know what you find? It's complete chaos. They aren't actually following the text in order, because they don't have a good strategy for how to look at a textbook with all of these distractions and things. So we actually can put the information up for you and show it to you in the way that the student got it, and you wouldn't understand it either.

So it's not that they can't read in the sense that they don't have good decoding skills, but what they don't have is good strategies for how to attack a text that has images and complications like this does. Okay?

Lastly, last part of the brain, and actually the most important one, are parts of the brain that are in the middle of your brain, so that's why I'm showing half of the brain here, and this yellow part, all of this here, very center core of your brain, it does a very different thing. It doesn't take information in, and it doesn't make strategic actions out. I'm going to read what I have here.

It monitors the internal and external environment to set priorities and to motivate learning and behavior. So the middle of your brain is all about what's important. What is it that you should be doing right now? And to know that, it's got to know what are, what's important to your survival right now?

Are you hungry? Are you thirsty? Are you bored? So it monitors that. The center of your brain is monitoring literally in your bloodstream and everything to say, where are we? And then it also has to monitor the outside environment. If you're hungry, where's the food? And it says food's more important now, because all of your ancestors that didn't know that died. Okay?

They didn't realize, because I'm hungry, I should be looking for food, and they kept playing checkers, okay, and they all died out. So monitoring the internal environment and setting priorities is what this center of the brain does. So when I showed you this picture, that part of your brain was also lighting up to determine what was going to be important.

And one of the things that could be important is that you like your teacher, and you feel like doing what she says, and so you answer the question. She asks the question, how are these people related, you look at the right parts. But if you're starving, in fact, lots of studies have shown that, in fact, you don't pay any attention to

the person's questions, you start looking right over in that right half of the thing and say, that looks like a table, is there any food on that? Okay?

And they've done all these in military camps where they can, you know, have people do whatever it is you can, if you can't go to the bathroom, then soon or later you'll start looking, is that a doorway to the bathroom in the back there? You know, you, so it's dominated by internally what's important to you, what it will be that attracts your attention and motivates you to learn things, motivates you to leave places, to come, to do things, and so on. Okay? Third part of the brain.

These all work together, usually, so that you have an integrated ability with things. That is, you take some information in, you evaluate it with the core of your brain to say, it's important to me, yup, and then you take some action. And you take action according to what's important to you. Okay? Is everybody with me?

So I show you a textbook, you've got to check it out, and first you've got to realize it's a textbook and understand there's text, and you're going to go have to do some work. Then you've got to check to see, is it important to me to be doing this, and you would say as a teacher right in the middle of the classroom, it is important for you to be reading this.

If the building is on fire, though, it's not important at all, and you've got to be smart enough to realize, I don't care what she's saying, we're leaving. Okay? And then you've got to say, our strategy now isn't to decode words, it's to get out of the building. Okay? So monitoring what's important. And kids, of course, come into the school with very different senses of what's important, as we'll see. Okay.

So those are the three main sort of learning, parts of any learning situation. I'm going to come back to them when we talk about how do we make learning environments that work for everybody. But I want to go to the second word in Universal, well, it's the first word, another word in Universal Design for Learning, universal. What do we mean by universal?

In Universal Design for Learning, by universal, we mean everybody. We don't mean special needs kids, we don't mean gifted kids, we don't mean regular kids, we mean everybody. We need an education that works for everybody. And by that, we mean, that's what we mean by universal.

But it's universal, not uniform, and that's the key distinction, because a lot of times we, in schools, have looked for standardized things as if that would get everybody, if we could do the same thing for everybody. And what Universal Design for Learning is going to say, you know what, you can't get there. That's not a route by which you can get there. We're not going to be able to get there by standardizing. We're going to have to get there by differentiating. Okay?

And so universal means we want to get everybody, but we can't them in a uniform way. And you've probably seen lots of slides like this. We now know that dyslexic kids, when they look at text, they look with different parts of their brain. It's, you know, no surprise now. We've seen this in probably hundreds of experiments. They're attacking the text with very different parts of the brain. They are not the same kind of learner.

And you can see, now that you know what PET scans are, you can see that, in fact, it's not that they're trying less, it's just that they're burning a lot of glucose here in strategic cortex, the front part of their brain, but they're not burning much glucose here

in the back part of their brain. Those parts aren't lighting up. They're not quickly and efficiently recognizing the patterns of text, so they're having to work at it to make sense of the text, to decode the text.

They're having to be strategic with text whereas these kids are automatic with a lot of it and being strategic about comprehending the text. Okay? So we can see they're really using a lot of different, now you're probably seeing that there's, in the literature, there's experiments which are trying to teach dyslexic kids to use these parts of their brains to read with instead of the parts, just the parts they're using. Okay?

Here's one that all of you as parents have seen or experienced, I mean. This is one about reading emotion. Can you tell how the person is feeling? And when reading emotion, teens are using some pretty primitive cortex areas in the, well, there's lots of words for it, but think more like the amygdala, not cortical systems, that, you know, really stupid animals have them. Okay?

We, as adults, well, let me say, so teenagers are using some primitive cortex kinds of, very different kinds of cortex, to read emotions with. They're not very good at it, okay, because the parts that we use, prefrontal cortex here, aren't mature yet. It's not wired up. So they're doing the best they can reading emotions with, you know, the machinery they have.

You read it with very different cortex, very good at it, and then it's always a surprise when you're kind of like, didn't you get it that I was being sarcastic or whatever, and you realize they are clueless about this. They're not reading your emotion, they're not understanding the emotional climate of the classroom, they don't understand it's a place to be quiet, all sorts of things. They're not good at reading yet. So there's lots of parts of the brain that are reading.

Reading emotion is one of them. But we grow into it. So some individual differences are just normal, but we grow into them. Okay. I want to talk now about individual differences in these three things, first, in recognition networks. And I want to talk about my wife, Ruth. Okay? Oh, I misprinted my slide here. I've, as you can imagine, some of these slides I use all sorts of times, and I actually changed a lot of this talk, because I'm so bored with my own talks.

And so that's the wrong word, but, you know, you're staying up late at night, and you've got the wrong word. So that should say individual difference in recognition networks. I apologize. And so here's the difference between Ruth and I in this arena. Ruth has perfect pitch. Oh, we have a huge crowd. By statistics, there should be people here who have perfect pitch. I won't ask you to sing, but does anyone here have perfect pitch? Nobody in the whole room?

Oh, somebody's pointing. Where? I see pointing. Great. You have perfect pitch? Fabulous. Okay. Is that it, only one person? It's sort of 1 in 1,000, so it's not, okay. So Ruth has perfect pitch. You're going to learn a little bit about your brain today. And what that means is if you sing a note or play it on a trombone or honk a car horn, whatever you do, Ruth knows that's a B flat. And it's not hard. It's not like she has to think about it.

You might like try to do it and say, oh, I think that sounds, and it's not for Ruth. It's just like you recognizing orange. Nobody, you just go orange, and Ruth just goes A flat. No problem. Okay? Now we know something about the neuroscience of perfect pitch. And what it is, is that people who have perfect pitch have a large area devoted to

pitch on the left side of their brain. It's an asymmetry. This looks a little weird. Okay? Big area devoted to pitch.

It's where expertise actually ends up being often on the left side, just for those of you that are keeping track. But anyway, big area on the left side, and she has perfect pitch. So now what I want to do is contrast Ruth and I a little bit. Okay? So I have had 14 years of music lessons. I just want it to be clear that I've tried. But I apparently have a BB-sized area for pitch. Okay? So I know it's high or low, okay, or in the middle, but I definitely have no idea that that's a B flat.

Okay? And that's going to be closer to where you are. Okay? We range all over the place between perfect pitch and, I forget the word for having no pitch at all. I'm somewhere down near that end. Okay. Now the question I want you to think about for this talk is who has a disability here? Now for you and Ruth, you're saying you have a disability? Good. Don't say why yet. Let me just come back to that in a second.

When in music class Ruth is a gifted and talented student, believe me. You can imagine. She got A's all the way through school, and she almost went to music school, and she sings semi-professionally now. It's like her, holy cow, boingo. Don't you hate it when things pop up like that? So she would have done great and did in music. I, on the other hand, tried really, really hard, and I never could get the pitch thing. Okay?

But in, so in music class, I got, and I did pretty well in school, but that's where I would get my bad grades, that and penmanship, to be honest. But anyway, but if we change the situation just a little bit, things are quite different. So I want to tell you about, Ruth and I go to church together, and in church, things, the context is somewhat different. A lot of this talk is about context. In church, let me give you my experience.

It's the only time I ever sing, is during the hymns. Right? And I figure that's why you're there, to sing loud. Okay? But I don't really, I'm not really, you know, on the B flat exactly, but who cares, you know, it's good. Okay? Picture Ruth. So she's there with me. She'd like to be affiliative. And when Ruth looks at the note in the hymn book, she knows exactly what to sing. And I'm singing something a little bit different.

So she has the, you know, this difficult problem of should she sing when I'm singing, because I'm her husband, or should she sing the actual note? It's a little difficult. Okay? But that's only part of the problem. The problem is the person on her other side, they don't have perfect pitch either. They're not really singing 440. They're singing something else. It's nearby, but it's not really the pitch.

So should she sing with that person to be friendly, should she sing with me to be affiliative, whatever? But it's even worse, because we go to an old New England church, and the organ has long ago drifted away from 440. It's not playing 440A anymore, it's playing something else. So Ruth has the pitch she sees in the book, she has the organ, she has me, she has her other neighbors, and so you know what Ruth does in church? She doesn't sing.

She is disabled in that environment, and I love the irony of people in the church who turn around and see Ruth, a semi-professional singer, not singing and thinking, you know, poor David, he's such a great singer, and there's his wife, doesn't even try to sing. And I love it. I love it. Okay? And for Ruth, on the other hand, things are quite different. Church is an anomaly.

But her view of what married life would be really comes from the *Sound of Music* that she pictured that, you know, she'd have a few children with some nice guy, and

then they'd be singing in a Volkswagen van, climbing over them, singing in six-part harmony in the, you know, etc.

And so it was a bitter, bitter disappointment to her that I turned out to have that BB-sized area and, unfortunately, passed it on to our offspring. So we don't do the four-part harmony thing. Okay? So Ruth has to go outside the family for that. So who has a disability, though, depends on the context entirely.

And I, and you said, actually, people with perfect pitch, and you may want to see her after, because people want to elaborate, people with perfect pitch often describe it as a disability as well as an ability, which is to say, it's annoying to you when you go to someplace, and the music isn't in tune. They've changed the pitch of the piece. They're not playing it in the original key.

All of these turn out to be problems, and Ruth doesn't sing in church. That, in fact, disability is always contextual, which is the point I wanted to make with print disability. But we're going to see this again and again. The child is disabled in a print environment is key. My wife is disabled in a church environment, okay, but she's fabulous at the Juilliard School of Music. So context is really key and important.

Here's just some, I want to check on my time. I'm, okay. I'm going to go a little bit faster. I just want to show how subtle the effects can be. If you look at this letter, I shouldn't have said a letter. If we show this stimulus to everybody in the class, you think, I've shown it to everybody. But, in fact, studies show that people, in fact, don't see the same thing, so it's just like pitch.

So this is a study that looked like students with Williams Syndrome, students with Down's Syndrome, matched for IQ, same cognitive abilities, they look at exactly the same thing, and then you ask them to just draw what they saw and look what they drew. On the left, the students with Williams Syndrome see only the detail. They see it's a lot of little things. The students with Down's Syndrome see it's one big thing. They don't see the details.

Now there's thousands of experiments like this. So when we, as teachers, think I've shown them, I've shown everybody the same thing, or I told everybody the same thing, it's a shock to find out they didn't hear the same thing, or they didn't see the same thing. But that's the way it is. That is how our brains work. Kids, and again, these kids are matched for IQ, they just see different things when you show them the same image.

Students who are blind are going to see even more variance. Students who are illiterate don't realize it's a D. Students who are cognitively disabled, blah, blah. Everybody's going to see different things, even as simple a thing as showing that. Okay. I'm going to go a little bit faster. Now I want to talk about individual difference in the strategic networks. Front part of your brain. You're taking action on the world.

The problem of Ruth here only became apparent when Ruth got me to take a Balkan folk dancing class with her. And how many Balkan folk dancers are there here? Are there any? There's one. Good. So you will know when I'm lying here. So Balkan folk dancing is one of those things that has fancy steps in it. It's not like square dancing where you just do what the guy says. You've got to, you know, do these little clicking your feet things. Okay.

So we took this class. Nice teacher, etc., and about 50 people in the class. And he would do, I'll tell you, this is exactly how class went. And we'll see where you were

on this. So the teacher would stand up in front of us, 50 people there, and he'd go, okay, you know dance number 42. Ready?

And then he'd go, do something like that, and then in my experience, there was, you know, like 45 women and 5 men in the class, as men stop being learners when they get to be adults. And my experience, all 45 women did it immediately, okay, and then me and 4 other guys, actually, had no idea what to do with our feet. And then over time, this repeated itself enough that we became the remedial group. Okay?

And he did all what special ed, I mean, I'm an educator, so I'm watching this, and I'm thinking, I know where this is going. So he moves us to the front so we could see better, you know, like it's a visual problem we're having so that we're in front of all 45 women who are thinking this is, these people are the stupidest guys I've ever seen. And then he would go into not you but sort of stereotyped special ed talk, because he, I'm not kidding, I remember this.

He'd go, okay, now, can you all point at your right leg. And this is in Cambridge, Massachusetts, and I'm quite sure those other four guys were university professors, and this guy talked baby talk to us, because it just seemed so stupid that we couldn't do it. So he's going, okay, good, good. Okay. Now touch your left leg. Good. You know, there was probably a Nobel prize winner or something there, and he was talking like this.

And then he says, okay, now slide together. Good. And we're doing this. Okay. And we don't get it, but he, you know, he spends most of his time on us, and all the rest of the class is bored, zone of proximal development problem, of course, and then he says, okay, I'm going to turn on the music, and don't think about it. Just enjoy yourselves. And me and the other four guys, we're not enjoying ourselves. We are doing what kids do.

You can see our lips move as we're saying, slide together, left, right. And he says, smile with your partner. We're not smiling. We're going, slide, left, together, and all that kind of thing, very different capacities. And I remembered thinking, you know, this is 14 weeks. This is not one week. So I also saw the drift happen with me, which is, ah, just think to yourself. If you visited this class at week 12, what would I look like?

What, if you looked at this whole class of 50 people, do you think I would stand out, and what would I look like? And I'm sure you could picture it. Yup, me and the other four guys, we became the class jerks. And it wasn't, we never made a decision. It wasn't like we all said, let's be jerks.

It was just inevitable, just sort of like, we just sort of drifted that way, and I experienced, and I, you know, I was trying to think this out, and I realized that, of course, it looked worse to look like you were really seriously trying, because then you just looked even stupider. And everybody's looking at you, and they think you're dumb, and then, you know, and you can't get it. And so the best thing is to make a joke and do something silly.

And, of course, we did all of the other things that people under high stress would do. We started skipping class. We got sick easily. We wanted to be in the back. He kept bringing us up to the front, all of the things that are common. So he had generated in us a sort of an affective thing, as we'll see, about what it was like to be there.

And by the end, we were even worse learners, so he'd try a new one, but we were already then so traumatized by being up in front of the class and doing poorly that

we were even worse than the first time. So we weren't getting better, you know, we were just getting like, there's only two weeks left in this class, and I remember another guy and I were talking like that. Two weeks to go, we're almost out of here.

So, anyway, I'm not a good Balkan folk dancer, but maybe you and I can do a little bit after. Okay. Okay. And in the, when we get to the UDL guidelines, we'll look at, well, what are the parts of, that go into being able to do, to express yourself effectively? And there's a nice movement in the brain from things here or about being able to move at all. I didn't have that problem, but lots of kids do have physical disabilities.

Then here, you'll see, we're going to talk about options for physical action. We need to have options available for people who can't move very well. Options for expressive skills and fluency, I'm not a fluent mover of my feet in the dance class. I'm disfluent. I have my problems here. Okay? And in that regard, I would seem disabled. Way up front, our executive functions.

They allow you to organize these skills and then these motor stuff to make something nice and fluid and strategic happen. So I don't have problems here, or at least I didn't in dance class, I had problems here. But what happened was I knew that people were misinterpreting. People were thinking to themselves, he is stupid.

They weren't thinking, he has some disfluencies. They were thinking, he's a bad learner. The teacher tells him, and he doesn't know, he doesn't do it. I don't get it. It's just moving your feet. And we do that all the time. And what we'll talk about in UDL is that we need to provide multiple means of expression. We need to make sure that the things we ask of kids, do we have ways that kids who don't have good motor control do it?

Do we have ways that kids who are disfluent can do it? But, lastly, do we have ways that kids who have executive function problems, can they do it, too, because, in fact, kids can have, and, in fact, I'll show you pictures. This is a kid that we started with our work, was physically disabled. It was motor only. He was fine, but people misinterpreted him, and when we saw him, he was slated to go to a school for profoundly retarded kids, not at all retarded.

He could not move his muscles. Once we attached him up to a computer, he learned sign language, I mean, Morse code at first, and then he learned all kinds of things, and now he's in community college and so on. Fine, above average IQ, but we didn't know that until we gave him an alternative motor system, which was through technology. This is a colleague of mine, Todd Rose, teaches educational neuroscience at Harvard and a great guy.

He has executive function difficulties. He's incredibly disorganized, but he's incredibly smart. But he can't be, and he works at CAST where I work, and we have to do things to put him in a good position to be smart, but he is really smart. But we can't ask him to, can you organize this meeting? That would be a disaster. Okay? So we give him like you would do, some templates, say here's how other people have organized this meeting.

You can do a checklist, whatever. We have things, and he knows what he needs, and he uses computers unbelievably well to keep himself organized. When we give him some scaffolds, he's like the brightest guy at CAST. Without the scaffolds,

people just say, he's too disorganized, you can't work with him. But, in fact, we get incredible power out of him, because we design the environment well for him. Okay.

Lastly, affective networks. I couldn't wait to get here to do this. I have never talked about this before, anywhere. Ruth and I differ on chocolate. The affective networks are the part that helps you evaluate what it is you like and what it is you're afraid of, all of those things.

And for normal people, unquote, chocolate goes right to your limbic system, the affective parts of your brain, because it's got some fabulous little drugs, you druggies, all of you, that just, your brain just lights up and goes, oh, give me more of that, more of that.

I mean, it literally does. It's a great, it goes to the, it goes right to the affective limbic system. But the usual mistake is made. I went to many birthday parties in my childhood where people made a chocolate cake for me thinking everybody loves chocolate. Well, actually, I hate chocolate. And I, it was just like when I got invited to talk at Hershey, I thought, oh, my God, I'm going to hell.

I'm going to be, and I get, I walk out of the van that takes me to here, and you walk in the lobby, and I smell chocolate. And I'm like, oh, my God, this is a nightmare. Okay. So the question is, so there are individual differences in what is important, what is affective. And the reason, by the way, I hate chocolate is that I had some violent illness when I was very, very young, and my brain learned, this limbic part of my brain learned that chocolate's bad. Okay?

So it isn't something that I came in with a chemical imbalance, but I learned over sort of years two to five that if I get chocolate, I get sick. So my brain, being smart, learned that. So now I'm not interested in chocolate. People always think, oh, don't you hate not liking chocolate, and it's like, you know, I won't say what it would be for you, but think of some awful things for you, and that's the way it is for me. It's not like I think, oh, I'd love to be able to eat that.

Can't do chocolate. My brain learned an aversion. So you're learning what things are good for you and what things are bad for you. And I realize I want to, we have individual differences that we come in with. This is some great studies that have just come out that show you literally can see how big your amygdala is, and it's, the volume is a predictor of how anxious you are. So some of you know you're more anxious than other people.

Ruth's more anxious than I am. Now they'll look and say, oh, my God, you can look at it right there in the brain. That's bigger there, just like it was with the sound pitch. Their amygdala's bigger. They're more anxious.

I will say, a study just came out this week, you may have seen it in the papers, that shows that your amygdala size predicts how big your network on Facebook is, because, isn't that interesting, because a social network is one of the sources of what's important to you. And so we can actually look and show that it's bigger in people who have big, big networks and smaller in people who have small networks. Cool. Okay. Some examples.

But I want to give you one example from school that's incredibly powerful. The part of me that hates chocolate, you always feel, well, can't, because I'm no longer allergic. It'd be nice if I could just convince myself that chocolate's okay, but that part is very tough to unlearn. It's a very old part of your brain, and it learns it, and it won't

forget it, because it's kept your ancestors alive. But it can get us in big trouble. So don't worry about what's on this slide.

It's just to remind me to tell you this incredible piece of research that's coming out from one of my students at Harvard. And I think it's going to be a dramatic thing when it gets published. She was studying kids' stress, and she was looking at, are they less stressed when they have a better learning environment? That's what she wanted to study. And she didn't get any good findings, and it's like what happened?

Then she looked more closely at her findings, and she found that, in fact, in the waiting room before kids did, they were going to do, kids were coming in, and they were going to read a passage. It wasn't very high stress. It wasn't, no big tasks. You're not going to, you know, not be able to go to college or anything. Just come in and read with me. And you can read on the computer or not. That was the study.

And what she, when she looked at her data, she found out that the kids fell into two groups, and they had no overlap. They were like dramatically different. One group was kids with learning disabilities, and they came in, when she wired them up, before they read a thing, they were, bingo, right here. Typically achieving kids were here. On, she did physiological measures. She's got wires on them measuring how stressed they are.

The kids with learning disabilities, before they read anything, just imaging they're about to read, were already at a high stress level. Now one of the things that research has shown us in the last five years is stress is damaging to these parts of the nervous system I'm talking right now. It's really bad for them. It's okay to have a quick burst of cortisol when a tiger's coming. It's not good to be on a high diet all the time of cortisol. It's ruinous and damages a brain.

You can take out the brain and look at it and go, oh, my God, this brain is under attack. So you don't want to be at a high stress. So what she's studying now is, are these kids walking around all day at a high stress level that's different than the other kids? So they are essentially in an avoidance situation all the time, which is not good for learning and not good for their bodies.

So if her findings hold up with more and more kids, we'll have to put a sign on the schools that say, this could be damaging to your health, unless we move to a better designed environment. Okay? So I want to skip that and go to what would it mean to design? Last section. I know you're thinking, how long is he going to go on? We're getting near the end. What do we mean by design, and that has changed because of the digital world profoundly.

We used to have to do learning through things like lectures and books. And the advantages of books are obvious to everybody. They allow us a standardized knowledge. They make it permanent. It could be uniform. Everybody gets the same story. It's great. Gutenberg was fabulous. But compared to new media, the disadvantages of print become more prominent. You might ask how.

Well, now the standardization is you go, what, everybody doesn't like it exactly the same way. The fact that it's fixed, and I can't do things with it. It can't talk itself aloud and all these things that digital things can do. And it's uniform, it's one size of text, and, oh, my God, some people like big text, and some people like little text.

All of these things, you go, oh, well, gee, that's sort of weird, I mean, if you grow up as your kids do like, oh, print's got some good things, but, gee, you can't do some

powerful things with it. Okay. If, in a standardized curriculum where one size fits all, then the problem is the diversity of kids. They're a problem. If we have standardized technologies, then the variation in students is the problem. In new media, they're very different.

In new media, there's a separation between content and the way it's displayed. So here's the knowledge that you would ordinarily put in a book. There it is. And here's some kind of display device. In modern technology, in print, the knowledge is embossed into the book. It's fixed. You can't change it. It's there. And that used to be its advantage.

In a digital world, you can have the knowledge, and it's separate from the display device, so then you can display it on all kinds of devices. And now you know you can put it on your cell phone, you can put it on a computer, you can put it on your refrigerator, you can, now it shows up on your car screen. I mean, it's everywhere. So we can have the knowledge separate from the display device.

But more importantly, and that's what the whole thing about NIMAS that I began with is that we can take that knowledge and display it in very different ways, not just like the same thing for everybody. So we can display it by different colors. Not a big deal, but, you know, just shows how flexible it can be. But we can go much deeper. We can show it as printed text on the top, but we can also put it out immediately as Braille, for example, so it's text you touch instead.

And it can, there's refreshable Braille devices now, so you can it happen quickly and automatically. We don't have to go through that whole book thing, blah, blah, blah, blah, blah. We can have it, I'm not going to bother here, we can have it talk to me so I can hear it. So the same text now could be felt, it could be heard, it could be looked at. This enormous flexibility of the new technology is what we're going after in something like NIMAS.

In fact, now there are avatars that will sign it for you. So we can have it, and there's dozens of other kinds of things. We can take that same knowledge and say display it this way. Display it as something I listen to, something I can look at, something I can feel, something I can see in sign language. And as you know, we're working a bit with Google.

Google has an automatic translation now from, you give it to me in one language, and they can spit it out in 42 languages immediately. So in textbooks, we've got it in one language. In a digital thing, we can say, give it to me in Serbian, give it to me in another language, the language that I come with. Okay. Lots of variety. But more importantly, we can build in adjustable challenges and supports, right into the technology.

And I'm showing this as an example, the, what do you call it, going to the gym. A gym itself, these instruments are not useful to you. They're only useful because you can adjust two things. You can adjust the support so that you're situated well, and you're not going to break your back while you're trying to exercise your arms. And the weights are adjustable.

So when you come in, the first thing you do to a good gym, and that's why you pay all the money, is so that you can adjust those. So you can adjust and get it right for you and say, you know what, I need 30 pounds of this. The great thing is that when I go into the gym, or the sad thing is, I almost have to always take weight off, which just ticks

me off. But anyway, I'm comfortable, and I got the right, so I'm in my zone of proximal development.

What we can do in a digital world is make, we can begin to get kids in their zone of proximal development in a lot of ways. What I want to do is show you, there's blah, blah, blah, Universal Design, but I want to actually go, sorry, I've got to, I realize I made a link for me. All that middle stuff is just saying what I said again in a more boring way. Okay.

So what I want to show you is your new product that does a lot of these, builds a lot of these three things into it, and I'll highlight them, because what I want to be arguing is that you need to be asking for curricula that look like this. I'm not trying to, I don't want you to buy this in particular or anything, and there are more of these coming out.

But this has a lot of elements of Universal Design for Learning built into it, because one of the things we talked about at breakfast this morning is doing Universal Design for Learning would be really hard paying attention to the, kids differ in all these three ways. Oh, my God, how am I going to do that? And it would be impossible if you don't have better tools. You've got to have much better tools to do that, you know.

And it's the same way, you can't build tunnels if you don't have good tools and so on. And really getting kids in their zone of proximal development, getting kids to make a lot of progress, is going to require better tools than typically we have. It's going to require things that aren't print disabled. So let's look at some of the things this does, and this will, you know, this'll be the only program I'll show, and I'll show you where you can go to get some other things like this.

But here it is. It knows who I am, and it's a science. It's a, what should I, it's hard to know what it is, but it's a, it's to use instead of things like an encyclopedia, but it's kids doing research, learning how to do research and write papers in science or history or geography, things like that. Everybody with me? So it's a, replace the library is what it could do, actually, but anyway. So here's topics. They're, it's gorgeous.

Kids like it, because it looks like them instead of like us. So you can just kind of browse around and, you know, find things that might interest you. But you can also get assignments from a teacher. Let's go into science, and it'll be organized by, these are sort of the big, broad topics. They did a lot of research to see what do people want to teach about. So I'm going to go into continental drift just as an example.

I've never actually shown this before, so we'll see how I do. But it's done with a Universal Design take to it, which is to say, let's look first at how we represent it so everybody can, it'll be useable knowledge for everybody. Okay? So we've got to do a lot of things, but it should be built in, so you don't have to do it as a teacher. So for here, it begins with a video on the topic.

Why? Because a lot of kids don't have the background knowledge to just begin reading. They're aren't going to know the vocabulary, they aren't going to know the context, all of that. So it says, you know what, start with a video, and we'll see how this . . .

[Videotape played]

DR. ROSE: Continental drift. It's just like two minutes.

[Videotape played]

DR. ROSE: Did I lose connection? May have, okay. I can't tell. I just want to make sure I'm not off the Internet. Anyway, we were just about to the end of that. Beautiful. Notice it introduced a lot of the concepts but also the words. But let's go, then what happens, we've got to go a lot deeper than that. So it says, now read it. But the important thing is, when you go to read it, kids are going to be at all kinds of different levels.

Let me open up this first. This is, would be like an encyclopedia entry, and I'm just going to be able to show you a few features. But can you see up here where I'm wiggling my thing up here, reading level? What reading level are you? We want you to understand continental drift, but it has the article written at three different Lexile levels that will span most of the kids automatically, so it's there for you. You don't have to write something new.

So you can have kids come at different levels. In fact, it's going to read it at the first level, go to the second, go to the third, building up their knowledge base before they do. Notice that it can, the entire article also can be done in Spanish. So if your kids are Spanish-speaking as a first language, have a way to quickly recognize what's here. But there's better stuff.

Up here, can you see what I'm wiggling, yeah, turn read aloud on, so text to speech, beautiful text to speech is built in, so if a kid is having trouble decoding, they can still read this text. They can read it in Spanish. They can read it in English. They can have it be read aloud to them while it's highlighting.

The important point is we're saying, we want the kids to learn about continental drift, but what we're going to do is universally design the article so that we're getting rid of the barriers that some kids might not have. Now people always say, does that mean you don't continue to teach kids to be readers? Of course you do that but not in science class. What we want is to make sure they're doing science.

And we want them to read a lot, which we've shown, lots of people have shown, that the best thing is to have them read a lot. So reading a lot with support is like learning to ride a bike with a lot of support, but the main thing is you have to do a lot. So turn on the tech supports, and all the words, every word, you can ask, what's that word mean, if I don't know what it means. I can do, all right, lots of things. That's just the beginning.

Then you can say, okay, that's a general article, but that's not about really searching and finding out information for myself. And you notice over here on the right, what's built into this program is the entire Grolier's Encyclopedia so that there are here, do you want to go deeper, do you want to learn more? Because what we want to make sure is kids aren't bored.

We can provide a lot more supports for some kids, and I haven't shown you them all, but we also need to make sure that kids can go and learn a lot. So here are other topics that are available in this same fashion, and every one is Lexiled, so everybody can know where am I going, what is the difficulty of reading here, I can get tech support, blah, blah, blah, blah.

All of this is built in, so it's expansive enough so there's not a top-end ceiling to limit kids, and yet we're, kids who are struggling can still go ahead and get really

interested in an article that would otherwise be too challenging. Because what we want to do is get them affectively engaged. And what we'll find, what we find is that some kids are willing to struggle at reading, because they care about this topic. There are 90,000 topics, I think, in there.

It's not like they run out. So kids, each kid becomes an expert in something. So the first part everybody does together. So that's a good UDL sort of thing. There are some things we all do together, but then there are really challenging articles and really supported articles and tons of information to go and get. Okay. That's only the recognition part of the brain. What we built in is a lot of supports for the other parts.

Now I'm not going to show everything, but I want to show, let's say, taking notes. That's an active thing that a kid has to do. And this, I'm going to take a note, because I just read something that's worth reading. And it opens up a little, nice scaffold for taking notes that, just like you've learned to do with students who are struggling, organizes it, makes, gives a good template in which you can write, but it's very powerful. But a lot of kids don't know what to do.

Kids don't know how to take notes. They don't have good models, and blah, blah, blah, blah, blah. So on everything that you're asked to do, it says, do you need help? So if I click here, I need help, watch what happens. Oh, this is where I've got to be online. I have this worry that maybe, nope, I'm online. Okay.

[Videotape played]

DR. ROSE: Now I just want you to watch what happens here. Yeah. It begins to, instead of telling me things, has me do things. Try it.

[Videotape played]

DR. ROSE: Okay. I want to be clear here. These are things that a good teacher can do but where kids don't get a chance to practice with that much.

[Videotape played]

DR. ROSE: Okay, okay, okay. I got distracted.

[Videotape played]

DR. ROSE: Great. Okay. So I'm engaged in doing it.

[Videotape played]

DR. ROSE: Now watch what happens.

[Videotape played]

DR. ROSE: Now just click, and it goes to start.

[Videotape played]

DR. ROSE: So it gets me going. I have to do, click the kind of, but anyway, it gets me . . .

[Videotape played]

DR. ROSE: So I can't remember which one is best.

[Videotape played]

DR. ROSE: Okay.

[Videotape played]

DR. ROSE: Watch what happens here. It's nice.

[Videotape played]

DR. ROSE: Okay. So now, kids don't know how to actually get things smaller, so he kind of just shows you. He crosses out things, and he starts to . . .

[Videotape played]

DR. ROSE: Okay. So that's the tutorial. There's tutorials and all sorts of things.

[Videotape played]

DR. ROSE: Sorry, sorry. I'm not going to review, because I don't want to, but anyway, he also makes you review . . .

[Videotape played]

DR. ROSE: Sorry. Okay. Save. Save. Oh, yes, I got it. He wants me to remember to save. Good. Okay. Stop. I'm not going to review. Bye, Hedrick. Okay. The, that's your tutorial. You can get to tutorial anytime you want, but there are a whole lot of those built in where kids actually get practice in doing things, they get used to highlighting things, they get used to finding good information, they learn about citations, it doesn't let you not cite, and so on.

Heavily scaffolded environment where we can get kids with a lot of different abilities to do good research. And the thing that I like about it is that it begins with a video, which most everybody can use, and it's captioned and so on, moves to article that you read, moves to a few key articles that they've selected, and by that time, you know quite a bit. It gives you good background knowledge.

And then it says, now if you want to go out to 90,000 articles, you can. And then the last thing is, because all of those are safe, the last thing is if you want to still get

more, you can go out to the Web, but by this time, they taught you how to search, how to know what's good, how to know what's bad, and so on, all built in. So anyway, I like it as a program that does a lot, not everything, but a lot of things to help students who struggle.

And all of the things that I talked about, you'll see at the top here, I don't have time to go into it, but it's, literally, we thought a lot about executive function. So it tells you where are you in the relationship to your task? You'll see I'm 189 days late for my task. And it shows you how much percentage are you done, because kids don't have any way of estimating. I don't know where I am in the task.

So it calculates, says you're about this far, and that's not good given you only have a day left. And that has a beautiful, teaches you to outline program that really, you can move things around the outline and so on. It's gorgeous. Anyway, just as an example of what could things do that would allow a wider set of kids to be successful. Okay? Now I'm just going to go to wrap up my talk. And I do need to wrap up, because I said I'd finish early.

I'm going to flip, just look with your eyes and not your brain. We've done a very large environment with NSF that hopefully you'll be able to purchase soon, which is full-year kind of curriculum, big kind of stuff, and it's really highly interactive, gets kids doing, we've done it, sorry, I should say who that we've done it with. It's not us. We don't know how to do science. One of them is with the University of Michigan for middle school.

The other is with EDC for high school, Big Science curricula, which are embedded with all kinds of supports like I just showed you but for doing science and getting the kids to think and read and so on like scientists. But for the kids who have trouble, every word's alive, you can get a meaning for every word, you can get it in another language, blah, blah, blah. All of those things are built right into the text, so I don't have to think about them all the time.

And there's a journal, and I've done that. Okay. So in an environment where these kinds of things are possible, we can design very differently. And what I want to argue is that we as educators now in this new environment, with what we know about cognitive science, with what we know about disability and ability, and with primarily what we know about new technologies, we need to look at our curricula and identify its disabilities.

And that's what I liked about the word print disabilities, that we have gotten good at identifying disabilities in kids, but the next step is to start to identify the disabilities that our curriculum have. And you'll find, and this takes a whole nother kind of talking about it, that you'll find your curriculum has sensory and perceptual disabilities. It only works for people who have good vision, for example. It has language difficulties.

It only speaks one language. Or you have to be able to read to use it, blah, blah, blah. If you start looking at your curriculum for its disabilities, it starts to get you in a better frame of mind. And we find that curricula, most curricula we have, print-based curricula, have a number of disabilities. One is they're disabled in who they can access, who they can, oh, who they can assess, it should say access.

That they don't, most of our curricula don't work very well for a whole lot of the kids in our classrooms. And they're disabled in what we can teach. That is, the science I was showing you can't well be taught at all in printed books, even when that Hedrick

was demonstrating things and you saw continental drift. Those are things that books just don't do well, and they don't prepare kids well for their future. This is my daughter. She just finished medical school.

And it was very interesting to watch her progress. The textbooks, and she went to Yale Medical School, so it's not like, you know, she went to Barbados or something, and they said, here are some textbooks, if you want to use them, go ahead. But there wasn't even any assigned readings, and most of the stuff she did was online. She was doing simulations, she was finding information, blah, blah, blah, all of that. Everybody was on the computer.

So we're not preparing our kids for their future by preparing them in a world that's dominated by print. Just, I want to say that we were talking this morning that it's so frustrating right now to be an educator and have me do this kind of thing where you can show something that you go, okay, we'll, that would be great if I had that for every kid and everybody had their laptop and all that and where I knew exactly what to do and all of that so that there's a great deal of frustration.

Because UDL is taking off, that seems clear, but without enough stuff to make it really workable in classrooms in the way that you really need it. So what's going to be hopeful, just I want to end with, what, and I guess I don't, it's not my role to apologize, but I want to say it is frustrating right now. It's hard, because you have to do too much work.

When you have to figure out how do I accommodate this textbook, how do I prepare a lesson tonight for kids that are such different from each other, and I don't have the tools David was showing yet, and, you know, etc. It is hard. And I want to, I actually do want to say that I think good teaching is really hard, and I think you're all, a lot of you are special educators, and you know it's hard, and I'm with you there. But it shouldn't be frustrating.

So some signs of hope. What are things that are going to, you have people here. Janet, you all know from this, and these are people that are here that have been working on the Accessible Instructional Media work in various parts of your state, but there's done, Pam is here, other people I met with for breakfast. There's lots of people in Pennsylvania who know a lot, and you have local experts, and that's really good.

A place to go is the National Center on Universal Design for Learning, which has, increasingly it's being really filled up with things that teachers really need, not curriculum developers, films showing teachers who are teaching in a good way. By the way, there are people in this room that are teaching as well as anybody in a UDL sense. It's not like there's fabulous people in Ohio that if you could only live in Ohio you'd be better off.

You're about average, and there are fabulous teachers here. So what we're doing at the National Center on Universal Design for Learning is aggregating great teachers, showing you what they did, here's, and then we're putting in the kind of scaffolds that you need. You need things that say, well, when I'm planning my lesson, what are the things that I should do, so those are all being worked on.

They're being worked on in two places that are really enormously powerful. One is the laws are changing. There are going to be more laws like ESA will include UDL, and that will mean that you get stuff automatically. When you get stuff from a publisher, it should all do these things. You shouldn't have to do it at home. You should be, come in and be ready to teach.

UDL taskforce, I skipped over it, but it's an amazingly powerful group, and it is not just special educators. It's the American School Board Association, it's the principals' associations, it's the NEA, the AFT, big, powerful, regular education organizations plus most of the disability organizations, CEC, etc.

All of those are part of the UDL taskforce in Washington, and they are just bird-dogging to make laws that'll make it sure that you get the materials you need on the day when everybody else gets their textbooks. And these laws are incredible. NIMAS, the one I talked about print disability, just opened the, Pandora's box, so that's coming.

UDL Implementation Resource Network is just starting, but I talked with the group this morning, and Janet and Susan, where's Susan, I saw Susan somewhere, there's Susan way over there, okay. Susan, I think, will join the IRN, maybe Pam, we'll see. Hopefully, you'll join. But that is a, organizations are starting to share resources among schools that are doing UDL. And you can find them on the National Center on Universal Design for Learning.

They're going to have their tab where you'll be able to get to them. So you can join in there, trade stories, trade videos, trade materials, etc., so that there are things that are happening at a very national scale. And it is happening in the, NSF has a huge UDL initiative. Most of, they're just supporting many projects to gets science materials that are all UDL, so you'll get them automatically at your school.

Google is working with us to try to make, how do we make authoring systems that everybody can make a lot of UDL stuff? So there are things coming, and I'm sorry it's frustrating. Here's all the UDL taskforce. You can see it's an amazing number of organizations, special ed, higher ed, blah, blah, blah, blah, blah. Why is it so hard and frustrating? Because we're in transition to a different state, I think.

And it's because our schools are so disabled by their print disabilities. And I guess I want to end by just saying, I think it's important for you to think of your school as having disabilities, think of your curriculum as having disabilities, because then you'll be nice to it . . . you know, and that you realize that it is hard work. We're trying to change schools so they'll be better for everybody, including better for you, but it's like working with your special ed students.

It's not going to be easy at first. You're doing, it's going to be hard work to get it, and the schools are very disabled. We have schools that really don't work very well and curricula that don't work very well, and changing it all at once is really hard. It will get easier, but it won't get easier unless you do your jobs.

And I think, I'm hoping you'll contribute to the networks, that you guys are going to be the best teachers in UDL schools anywhere, and pretty soon they'll all be coming to Pennsylvania and seeing what you're doing. Thank you so much for your attention.