THE BROOKINGS INSTITUTION

LEVERAGING TECHNOLOGY TO RECLAIM AMERICAN EDUCATIONAL LEADERSHIP

Washington, D.C.
Friday, December 17, 2010

THE STATE OF EDUCATIONAL RESEARCH AND DEVELOPMENT

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P R O C E E D I N G S

MR. WEST: And for our next panel on the state of educational research and development, I'd like to invite my colleague, Allan Friedman, to come up and moderate that panel, along with Dan, Brett, and Bror.

Allan is a new fellow in governance studies at Brookings, and he's also the research director of our Center for Technology Innovation.

MR. FRIEDMAN: Thank you, Darrell.

Now, we talked a lot today about the importance of some new ideas, and we're very fortunate to have a panel here that has been very active in exploring and pushing the boundaries of what these new ideas are.

So, Jim mentioned the fact that we don't spend nearly enough on R&D, and certainly if we promoted more R&D and it was of the quality that this panel can promote, we'd make astounding progress by leaps and bounds.

We have some representatives from the academic research side, the private sector side, and the government and defense community, and I'm just going to briefly introduce the panel, and then we'll talk a little bit about some of the work that you've each been doing and then maybe move the conversation to a more general question of some of the hurdles and challenges of educational R&D.

So, starting with Brett, who is the program director in social psychology at the National Science Foundation, and before that he was faculty at UCLA and then SUNY Buffalo, and then he's also worked as a researcher for a Gallup organization and has done some work on self-concept and self-evaluation and self-regulation.

So, Bror is -- the full title is chief learning officer at Kaplan, and before that he has been extensively involved in a wide range of educational technology firms, including K12, Inc., Knowledge Universe, and before that he was in the private sector. He also knows a great deal about education having two bachelor's degrees, a master's in mathematics, a Ph.D., and an M.D. So, someone who knows a lot about education from all sides.

And, finally, we have Dan Kaufman, who is at DARPA as the director of

Information Processing Techniques Office. He's also the director of the Information Innovation Office, and prior to that he spent some time at DARPA developing computer games that allow soldiers to rapidly understand their deployment. And he's also worked with In-Q-Tel helping work at the CIA and has also spent extensive time in the private sector both in game development and in entertainment in general and before that was a lawyer in the high-tech sector.

MR. KAUFMAN: Awesome.

MR. FRIEDMAN: So, Brett, I was wondering if you could tell us a little about some of the work that's going on at the NSF and some current trends.

MR. PELHAM: Sure, I'll tell you about at least some -- a little bit of my own work and some work in my field that may sound a little far afield from the kinds of things folks have talked about today but I think are very relevant to the complicated picture of education, especially in a very culturally averse nation like the U.S.

Let me just give you a few quick findings. I'm going to give you a sentence or two about entire research programs, so I'll try to go quickly.

Asian-American girls and women who are asked to check off their ethnicity before they take the SAT or an SAT-like test do better than Asian-American girls and women who are asked to check of their gender. So, if I suddenly remind you that you're Asian-American as opposed to suddenly reminding you that you're female, you do better especially on mathematics tests.

Okay, what's the basis for that? Well, there's a very profound social basis then, things like stereotypes. If a teacher, for any reason -- your ethnicity, the brother who's a troublemaker who came before you, the fact that your gender is female as opposed to male -- has an expectancy about you, especially in the early years of school, that unconscious expectancy, not an ill desire on the part of the teacher, has a powerful effect on your performance throughout the school year. So, if teachers think that you're bright and you're going to do well, you probably are going to do well. If they think you're not so bright, you're not going to do so well, or maybe you are bright but you're a troublemaker, you're not going to do so well over the course of the year.

If you take white males in college -- Jeff Stone has done these very studies -- and you tell them I'm giving you a test to your sports intelligence. It's a putting skills test. You have them do that exam and you tell them it's a test of sports intelligence, they do substantially better than if you tell them it's a measure of their raw athletic ability. African-American children, the reverse trend. If you tell them it's sports intelligence, they do worse; if it's raw athletic ability, they do better. Exactly the same skills, exactly the same task, framed a little bit differently that are stereotyped consistent versus stereotyped consistent and you see radically different performances.

One more example in the form of the case study that is based on research, my seven-year-old son was forced by me -- I don't know, I was in an evil mood the other day, about a month ago, actually -- to watch *Dora, the Explorer* with my two-year-old daughter. I wanted them to have some time together and I was cooking and so, you know, why don't you do this. I can hear my son to Dora saying what did you like? And he says chewing up razor blades. And what does Dora say? I like that one, too. And of course my two-year-old daughter is hearing this and I run in there and intervene, but the point is Dora's not a very responsive teacher. She's cute, she's cuddly, she has fun things to do, but she says everything is right. No matter what you say, she likes it, too.

Well, Pat Kuhl has done a lot of research at the Life Science Center at the University of Washington that show that kids don't learn much in situations like Dora, because Dora is not responsive. She says the right things. She always gets her addition right, but she doesn't respond to the cues that you're me as a learner about what the right answer is and what the wrong answer is.

So, these are three or four quick examples. I could give you dozens more in my research area and other research areas that show that learning is an inherently social process. Kids learn from teachers, from their parents.

Another quick finding. Twenty-two years ago in graduate school, I learned about the study in a course in gender that somebody had finally claimed to show -- you know, we've been trying to show this for centuries, because, you know, men have to be better than women at

certain things -- somebody claimed to have finally shown that men are better at the extremes of math. So, math, you know, especially in the lower grades, girls do just as well, maybe better at math as boys; but if you look for the truth mathematical geniuses, it was argued, there are way more boys than women. So, teachers gave the math SAT to I think sixth- and seventh-graders, and they found that boys were 10 times more likely than girls to score at the extremely high level. And they said look, this is not even being taught in school; it's obviously not a schooling -- now there are more boy idiots, too, was their argument, but there are also more boys who are geniuses; we've got to pay attention to this and find those geniuses and train them. Well, it took about 10 years for somebody to do a follow-up study that said well, that is the case, we replicated that finding, there are more boys who do really, really well and really, really poorly on math even on a test that you'd think they've never seen before until you step outside the classroom and see what's happening at home. As it turns out, parents about 10 times more likely, when they see that their son is really good at math, to spend time at home working on math with them. And when a daughter shows the same aptitude, parents are way less likely to pull her aside at home and spend that extra time with her.

So, I'm giving you examples of successes and failures in the social sciences that show very clearly how complicated this picture is. And when people ask me why I work at the National Science Foundation as opposed to other jobs that I've done, I say that one of the goals I have is to bring the science of social behavior to the world, to teach the world that most of the problems we face today -- including educational -- problems with the educational system -- obesity, aggression -- those are social problems. We're not going to solve those problems by inventing better fMRI machines or better systems for surveillance. We're going to solve those problems by understanding human social behavior in a social context, and I would argue that education is a great example of how we need to do that.

I would also argue, unfortunately, that the situation is sufficiently complicated that there's not just one solution. So, when I teach my students -- used to be at UCLA, more recently at UB -- about the causes of stereotypes, and I tell them what we can do, I say I have bad news for you. We stereotype each other for a dozen or more really well-validated reasons. That

means it's really hard to change stereotypes. If you want to change gender stereotypes, there are a dozen different reasons why they exist. I don't mean little reasons; I mean big reasons.

And so the challenges teachers face are social challenges, and of course one of those social changes is the digital divide. We develop amazing sources of technology, and the kids in Bethesda -- there where my son's lucky enough to go to school, not because I live there but because his mom does -- those kids don't have problems with technology. They don't have problems with teachers who are there prepared and ready. But my nephew, who lives in a trailer park in rural Georgia -- he does have that problem. There isn't a computer in his school. His teachers have difficulty keeping the kids awake, because some of them don't get much sleep at night and don't get breakfast in the morning. So, we have very different problems for different groups of kids.

So, if you look at PISA scores -- if you look at the PISA scores of middle-class American kids and upper-class American kids, I'm sure we do very, very well. If the PISA scores of those kids in rural and often inner-city ghetto schools who are not doing so well is because they don't have access to basic resources -- not just a lack of access to technology but to basic resources.

So, I realize I'm jumping around a lot, but the general point I want to make is that this problem is a very real problem, but it's a very real problem that requires social solutions as well as technological solutions.

MR. FRIEDMAN: Thanks.

So, Bror, some perspectives from the private sector?

MR. SAXBERG: Sure. I'm the chief learning officer of Kaplan, and so I look across all the different business units that Kaplan has. Kaplan has more than a million students a year worldwide that we teach ranging from tutoring mathematics for six-year-olds and seven-year-olds on up to high school students of various kinds -- test prep -- I won't ask you to raise your hand if you've been to a Kaplan course -- and on up through certificates, diplomas, all kinds of postsecondary bachelor's degrees, master's degrees, and on out to continuing education. So, we really do run from ages 6 to 90, basically, around the world. And my charter is to look across

all this and coordinate the underpinnings of learning for all the different business units so that we move toward a common understanding of how learning works and that we begin to benefit from having more than a million students a year.

Learning and technology, technology and learning -- it's interesting. You know, technology is fairly recently. My kids like to torture me by speculating on which came first, the wheel or Dad's first computer. And yet, learning has been around a long time.

I am the grandson of an illiterate truck driver. It's not as if humanity has been unable to learn, right? There are some examples of extraordinary movements in learning over time. The challenge is how do we scale this up so that it's not just .1 percent or less who are able to make some kind of extraordinary movements and how do we increase the pace. And this is part of what we're engaged in across Kaplan.

The way I think about this, probably because of my own M.D./Ph.D. work as a research guy in the cognitive science world, AI world, many years ago, is you have to figure out your learning problems first. It's the learning science that has to come first. What is the learning problem? And this actually is true for technology as a whole. Technology actually never solves a problem. Technology can take a really bad solution and make it work really quickly, right? And it can take a really good solution and make it work incredibly efficiently and quickly as well. But notice you have to have the solution first, and then technology completely changes the dynamics, the scalability, the cost, the reliability, the way data flows and allows you to innovate, et cetera.

So, several things around the learning side that we are doing that we then think technology will really help us. One of them is making expertise visible. There's actually a whole science around what experts are like, and it turns out it's not what you might expect.

Seventy percent or more of what makes experts experts is actually subconscious: subconscious capabilities of pattern recognition, complex procedures. For example, I'm going to ask you a question. How many of you drive a car? Raise your hand if you drive a car. Okay, that many people are awake. That's terrific. (Laughter)

How -- oh, sorry. Now, how many of you have had this happen to you? You start out driving to place A, then you're thinking about your job or your work or this meeting and

you look up and you're at place B. Raise your hand. Has that ever happened to you? Look around. Look around. Right? Lots of people are raising their hands, right?

Who drove you to place B? You know, where did they come from? You were thinking about something else. Were they in the car when you were 16 and the state trooper, right? So, this is common to all expertise, that there are patterns that exist that subconsciously become fluent.

There are techniques from cognizant science called cognizant task analysis that let you make the invisible parts of expertise become visible, so we're now doing pilots in various of our programs within Kaplan to actually do that and then tie that into instruction, because research shows you can cut the time of mastery by 20 or 30 percent or more, and you can have students who graduate from those programs who essentially make no mistakes. It's actually quite extraordinary, the results of that. So, were working on that kind of thing.

The second major area that we're looking at the learning science and then using technology to enhance things is optimizing education. And you've heard a lot about that already today. One of the areas is just data. We're collecting data on a hundred thousand of our -- 90,000 of our students as they perform and using that then to evaluate how the courses are working so that we can then target investment into fixing pieces and whole courses using technology. That kind of data has allowed us to see that when we add some adaptive technologies to some of the math courses, we've had extraordinary gains in the retention of students in fundamental math courses. And in postsecondary work, our student populations are very high risk, so this is a big deal to be able to help keep them in.

We also are building out a kind of concept car where it's a, you know, kind of an extreme sports version of electronic education, just like automobile companies make concept cars? You know, they're usually not street legal in Iowa, so I don't think this course will be street legal in Iowa, but it's going to illustrate as many of the cognitive science principles as we can dig our hands on with real data behind them around knowledge -- advancing knowledge, how screens affect learning behavior; how do you diagnose and understand motivation from some of the motivation theory work; and how do you enhance meta cognition, the understanding of how

learning is progressing so that students build their skills for learning as well as they build their specific domain skills.

So, the final thing we're working on -- and I think the whole industry needs -- is faster pilots. We've heard about scale and the need to do this faster. We have a facility with our own test prep unit that can do randomized control trials online very quickly, so we did one of them -- 900 students -- in about 4 weeks looking to see whether video helped or hindered learning and were able to use that to change how we were developing programs. Well, okay, so we're a big company or whatever, but, my goodness, there's 50 million in the U.S. I mean, how many of those experiences are we actually learning from? Nearly none. I mean, it's not .1 percent of budget. It's almost -- it's essentially 0 percent of students from whom we're learning. So, we need to set up better facilities for doing pilots quickly and well I think.

You know, ultimately, we as a large company -- where are the cogitech companies, right? The biotech industry is filled with little strange companies coming out of a wish and a prayer from universities. Most of them fail after trying for a few years. But where is the cogitech industry that a large place like us can say whoa, I want that, that's great, let's scale it up, let's go. And I think that gets to the demand issues people have been talking about this morning, which I thought was really smart, that -- you know, we have demand. We have an appetite to increase learning, and it really helps us, so we want that to happen. But in the marketplace, boy, there's not so much of that demand to be able to plug into. So, ideas about how to do that I think are very -- a big deal so that you can get more innovations and uses of technologies that drive learning that and that what comes, you know, to market can actually be deployed at scale, because it's very hard to do this work by, you know, the tens of thousands. And that becomes a key part of what you want to incent people to, to innovate.

But those are the few things that we're trying to do within Kaplan.

MR. FRIEDMAN: Thank you.

Dan, you want to talk about some of the cool toys you've been building?

MR. KAUFMAN: Okay. Yeah, it's sort of the most fun thing at DARPA I write, because I came out of the commercial world with the DreamWorks and Microsoft and, you know,

you have to deliver ever quarter and at DARPA they give you the freedom to just be a little crazy, which somehow fits me, so I'm going to touch real briefly on a few things we're doing. If anybody's interested, we can follow up more but just give you a taste of them.

One thing that -- I've heard a lot about digital tutors. We have a big digital tutor program going out. Just to give you an idea, we've done it -- we took a bunch of Navy freshmen basically that never had any IT training whatsoever, brought them in, brought them through the digital tutor course, and they have consistently out-performed people not only who have graduated the course but have five years worth of experience. So now, whether that expands beyond IT, I don't know, right? But it's pretty cool.

Another thing we're doing but to just give you the idea of breadth, we're looking at neuroscience in a really, really deep way. We were actually funded some research that actually is looking at saturation levels. In other words, could -- I could hook up an FMRI to your head and figure out, you know, when should I stop studying? I have a son who's a freshman in college. I think he would love to know that. You know, when did you hit that burned out level. You know, you've just studied enough and you should just take a break. There's a way to optimize that, so we're looking at things like that all the way down to are there ways -- you know, we take Gatorade or we can take oxygen to improve performance. Could I make a student more ready to learn -- right? -- not modifying things but just stimulate that, think about the brain as a muscle.

Other things we're looking at -- I have a simulation program that we put out to a lot of the schools. We're letting a lot of the kids build a -- to make it as easy as you use Word or PowerPoint -- to be able to build a simulation with all the physics. And what I like about that, as I call it, learning is a Trojan horse, right? So, you're just out there having fun. You can build any video game you want. But in order to do it, you have to start to actually understand the logic of programming, understand the math. But I'm not teaching any of that. You've just decided you need to learn that, right?

Another thing we heard a lot about on the buy side -- we have a program out called transformative apps, which says -- look, I can't reform the acquisition process, I tried, you

know, it's not going to happen. But what if you end run it. So imagine that I could give -- instead of trying to convince people to change I gave all the soldiers virtual dollars and instead of paying for them -- instead of them paying to buy an application I'm going to reward based on usage, right? So, I don't want to pay $50 million to develop a language translator. I'll let the market decide it. I'll give 50 million bucks to the one that everybody likes, right? So, pay for what I want, not for doing it.

So, we have a lot of different things like that. The newest one we kicked off is something called Engage -- doing it up with University of Washington and some other places -- that I think is really neat. The idea of moving from a theory-driven method of learning, which -- and there's tremendous value in it, right? I want to be clear. But to a data-drive one. I did a program called FoldIt in my tour at DARPA where got 13-year-old kids to compete in biotechnology tournaments against PhDs and supercomputers, which was just really fun if no other reason than that, and we finished third. So, it wasn't so bad.

Questions -- could you apply that to education? Can I do that algebra and fractions, you know? And by data-driven what I mean is imagine a merchant learning coming up so that I have thousands of kids and there -- I'm watching the way they learn and I'm changing what they learn based on what they're actually doing. So, there doesn't have to be a right theory. I can watch them.

And imagine that I can tap into the power of a crowd source in the social networks where the kids become the tutors themselves, right? Think about it. They're closer to understanding the breakthrough than any teacher possibly can be, because they just did it, right? They know what worked for them, and you can imagine groups coming along on this. So, we're pretty -- I'm pretty excited about that stuff and being able to track it and change it in real time.

So, this came about because one of our performers has a little girl, and, you know, he heard all the horror stories that I hear today, which just terrifies me that, you know, they all fail out and they're never going to do anything, and, you know -- and so he went and he said not my little princess -- right? -- no, not going to happen. So, he went to the first school and he said how do you teach fractions? It seemed a very reasonable question. And they said, oh,

because we teach a half a quarter, an eighth, a sixteenth. And he said, well, gee, that makes perfect sense, felt comfortable, went to the next school and just asked, curious, and it was like his control question. And they said, oh, we teach a half, a third, a fourth, a fifth, a sixth. And he said well, wait, I thought you were supposed to do a half, a quarter. They said oh, no, no, no. See, that's much easier and they learn faster, but they don't really understand the abstraction level; you need to learn a half, a quarter, a fifth. He went, oh, okay, well, I guess that sort of makes sense. And he went to a third school, said oh, no, no, that's completely ridiculous, we use manipulables. So the key is you've got to put down pizza pies and they divide it up. And he said, oh, my god, we don't know. (Laughter) And he didn't know what to do. And the thought was maybe I could drive it to this data driven and maybe there is no one answer but I could build a platform to do that.

And then I'll leave you at the end. This is a story our director tells, but I really love it. Somebody asked me a while ago don't you get depressed, because you look at this huge number of things. We've heard everything wrong, right? Buying problems and frameworks and teachers and unions and just all sorts of stuff, and so she tells this story about an author, famous author who every morning to clear his head used to walk along the beach. And one day he sees a young girl dancing on the beach and it's just -- you know, it's enthralling. It's entrancing to watch this little girl. He gets closer, he watches her, and he realizes that she's not dancing at all. She's bending over and picking up starfish and chucking them back into the ocean. And he watches for a little while and then he can't help himself, He walks up to her, he says, little girl, don't you understand there are thousands of miles of this beach and there's thousands and thousands of starfish, and you can't possibly get them all back in the ocean? You can't make a difference. But she looks at him like little girls do, you know, flips her hair up and says, well, made a difference to this one.

And I guess to me that's sort of my take. So, yes, we have a lot of things to do. We have a lot of programs here at DARPA. I've heard about a lot of good things. But it's all just about one, you know? And for me that's the core.

MR. FRIEDMAN: Excellent. So, quick question playing off that, and this would

be to all three of you. How do we reach that one? How do we have --?

MR. KAUFMAN: Play basketball. (Laughter)

MR. FRIEDMAN: Well, thank you, Dan.

MR. KAUFMAN: Maybe it's something I said. (Laughter)

MR. FRIEDMAN: That'll teach you to take her joke.

Well, so, how do we reach out and make sure that that one is the important one and this is sort of a diffusion-of-innovation question, because we've talked a little bit today about scale and there's scale on the technology design, making it available, accessible. But also there's scale on the political side, and there's scale on the social side of actually making it useful to each student because we've also discussed that, you know, everyone really is an individual. So, can you talk about how we take some of these fresh ideas and roll them out in such a way that, you know, we can actually get them widely distributed.

MR. SAXBERG: Well, one way is, you know, the kinds of innovative models that have already been talked about -- and being in the private sector myself that's part of what we're doing -- is we're trying to offer, directly out to people who want to learn, systems that want to try something new, ideas that we can scale up and aggregate various kinds of demand together.

The other thing, though, about that is, you know, the personalization aspect I think is incredibly important; too, so that people start to feel like organizations, systems really know them. And it turns out, there's learning science behind this, too, that as you create learning experiences that are challenging but not too challenging that take advantage of what's already in long-term memory so that you're not forcing working memory to get too overloaded, learning gets more interesting. It actually is really pleasurable, unlike how a lot of our systems that are more cookie cutter make people feel about learning. So, by personalizing the learning and making it clear you are doing that and that you can repeat doing that, you are actually welcoming people to come back. And I think, as people know from mega trends and other things we heard here today as well, with this acceleration of career destructions and creation, you know, where do you go to get advice, you know?

I started life going to college wanting to build stereo equipment. You know, my

mom and dad weren't setting me up to be a chief learning officer, you know 30 years ago, and I've been a managing consultant myself. I've been a research scientist. I've been involved with other companies around learning and, you know, how -- you know, we need better tools to help personalize my next transition -- right? -- so that it would take account of the fact that, yeah, I know research, I know M.D.'s, but I'm not really an English person at all. So how should that affect what I do? And once I started to get confidence about that, I'll actually start accessing tools more, because I'll know that I can go there and get change. So, I think it's a combination of the demand side of getting folks to buy these things and work with them and bring them out, but I think it's also a customer experience side, a learner experience side. Once you start to be able to trust that environments will be engaging and successful, you'll come to them sooner I think.

MR. PELHAM: I think that's a great answer. The great thing about a question like that is there's many different answers. My answer would come from a different perspective.

I come from a family of a few teachers, a family of, you know, parents who didn't even finish high school but of whom my siblings -- the six of us -- three of us are involved in some way in teaching, and one of my brothers just became a principal. And he told me a story about a kid he had in his class last year, the first year he was a principal, who just wasn't coming to school, and he couldn't find out why. He tried to get to the bottom of it. He learned eventually that the kid's mother just wasn't bringing him to school. She had some drug issues and other issues. So, what he told her he was going to -- and did for about two straight weeks -- was go to his house every morning and knock on the door until she brought him to the door. And needless to say she became very irate and then she moved to a different school system. (Laughter) But in that -- the rest of that academic year, that kid was at school every single day, because eventually she learned, yeah, you'll come the first day; you're not going to be here tomorrow. He was there tomorrow. He was the next day.

So, what I'm saying is it comes down to teachers. So, I agree with the things that were said about unions, that often these things are politicized and there are barriers, but I think most teachers work really hard to be good teachers, care deeply about learning. And so they are the ones who can really personalize learning.

Parents, of course, also play a huge role in doing that. So, if you want to know how to personalize things, you take what we know about learning and student engagement and things like that, and teachers and parents apply that.

So, for example, Gallup, where I worked for a couple of years, knows a lot about how to motivate employees, and they're now applying some of that to how to motivate students. And one of the things that you do is you identify people's unique strengths. They have a list of 34 of them. Everybody has some. Some have more than others. Everybody has some things that they feel really good at and are confident doing, and so teachers and educators and parents intuitively often learn that and do that, but of course Gallup gives people a formal way to do it.

You can test people and say these are your five signature strengths, and if a teacher knows that about a student, it gives them an ability to communicate with that student at a more personal level, challenge that student in ways that they wouldn't otherwise do it. So, I think there's tons of knowledge out there.

Bob Sternberg's work on how different people learn in different ways, college professors at least have applied that. So, there's a lot of work about how people learn, and I'll use this as a chance to mention one other program that I'm a part of at NSF, which is the cyber learning solicitation that came out, I believe, in early October. So, if you're a researcher here who studies education, they're particularly interested in solicitations for new research proposals that have to do with using technology to improve the education process, especially in ways that personalize learning. So, in other words, software programs or computer programs of any kind -- I say wow, this kid is really good at this, let me push that.

So, you know, if we have technology -- when I go to Amazon.com, it says people why like that book also like this book? (Laughter) You know, Amazon's great at that. They -- it's like, hey, I did like that book, that's great, how'd they know that? Because eight other million people who bought that book also bought the other book. So, if we have that kind of technology readily available in the marketing community, why can't we do things like that with learners and apply that technology, say wow, kids who are good at this task often enjoyed this task and get engaged in that task. And, of course, teachers do that at an informal level, but, you know, my

basic answer comes back to it's up to teachers and parents to do that, and technology can enable them to that even better.

MR. SAXBERG: Interesting comments and spark a couple of thoughts. On is another plug for the McKinsey Report that came out earlier. One of the things that look at exactly as Jim was saying is these stages of learning of the most improved school systems around the would -- what do they actually do? One of the things that applies at several of those levels is to provide teachers with support based on the differentiation of their students so that, you know, it's like teachers are your general practitioners but that they have access to specialist tools, programs, and other things that they are able to guide and control. So, you don't want your teachers to be left alone with a huge variety of problems and challenges. You want them to be trained and have available to them tools to do this.

And you just mentioned that idea of using technology to enhance that. We've heard several ideas like that. Within Kaplan, as well, we're piloting where we have an adaptive homework engine that students are working on the night before, and then that homework engine actually feeds to the teacher the next day a suggestion for how to group the students into three different kinds of activities where the scaffolding and the type of the learning is different for those three. And that way, the teacher gets guidance based on homework from last night and the trajectory of learning in the past to have suggestions about how that should link to the exact activity that's coming that next day. And, you know, if you're teaching for one type of thing or another type of thing, the groups just start moving around, and it's driven by data to guide the teacher.

Now, teachers know more than data, so they can do what they like in terms of where the students go, but it gives them a first cut at what the data suggests you might want to do as a subgroup, and I think that's all part of giving teachers, you know, better tools to customize and personalize their instruction, which will make it more compelling, and students and parents will feel like maybe I don't need to start reaching completely outside, now this environment really knows my student. He comes home engaged or she comes home engaged and excited because there's been a matching to that student's capabilities and progress that's dynamic, not

stereotypical.

So, I think there's a lot that can be done on that front. There's no question.

MR. FRIEDMAN: Sure. So, I can think we can open it up for some questions from the audience if -- one over on the side there.

MR. MOORE: Travis Moore with Congressman Waxman. What would you all like to see come out of ESEA reauthorization, especially from the technology side?

MR. SAXBERG: Oddly, you know, in some ways I think the most important things that can come out of a lot of these policy and government decisions are likely to be less about technology than about learning, than about focusing deeply on really effective standards, which now look like they're in place for K-12, but I would say for higher education as well -- you know, where the government-funded cognizant task analyses of different key professions so that all the rest of us can start competing against how do we deliver those. I mean, we're having to do them, because nobody is doing them, but that would be a great standardized thing to look at, you know, the best performance and create standards for careers and professions as well as for the K-12 space.

And then the data ideas -- you know, the notion of not being scared to make data transparent and perhaps through policies push it, really start to talk about you need to make data available and transparent as part of decision-making and have that be a component of that. So, to me it's not so much technology as it is more about learning and transparent information that are the key things to come out of this, but I -- Bret, your thoughts on --

MR. PELHAM: I don't have expertise in policy enough to answer, so I would trust your answer. (Laughter)

MR. FRIEDMAN: Other questions? There's -- in the middle there on the aisle?

MS. KLEIN: Hi, Andrea Klein with the Total Family Care Coalition. With regard to research and development and allocating funds for it, what do you think would be a good formula with regard to government dollars, foundation, philanthropic dollars, industry dollars, and then the role of nonprofits supporting in their area of specialty?

MR. SAXBERG: Shall I take it -- start?

MR. FRIEDMAN: Go ahead.

MR. SAXBERG: I'll start, sure. I'm M.D./Ph.D., so I look at education with kind of double-vision, and so I think about the health care model and I think there's a lot to offer from the progress of that industry over 70 years as it's developed various mechanisms, and even the whole intellectual property issues are really important if you want to galvanize both the research community and the business community to actually get the real implementation.

It's pretty clear the first answer is "more" -- I mean, 0.1 percent. One of the telling aspects of this is education companies don't even bother to report R&D in their accounting statements. I mean, so many industries actually have an R&D line. Education companies don't even think there's a reason to talk about it. Think how extraordinary that is. We've built an industry that doesn't appear to be where it's worth telling the financial community about R&D in some ways, and so I think that that reflects, you know, a miss about how important R&D is.

And, you know, it's probably that you would like to have seed fund for the longest term projects to come out of the federal government. That's been the standard in many other areas, and then you know, keep working -- you're way down to the most dollars possibly being in the real implementation work, the real "D" work that gets you final products that come out.

Your thoughts?

MR. PELHAM: I'll give you an answer that reveals my ignorance about education in general but also the fact that I am a social scientist and I'm a statistician, so what little work I did at Gallup on education -- I was always the stats guy and the social science guy, not knowing much at all about how education works, so I learned what PISA scores are and that sort of thing.

But in some of the modeling I did for folks at Gallup I kept seeing this outlier -- and it was Finland, by the way. I was like, huh, Finland keeps doing really well, wonder why. So, I did -- I had no idea why. Well, I did discover one of the reasons why Finland does better than us -- I think one possible reason. You know, obviously these are not longitudinal studies and we can't draw a firm and causal conclusion, but one of the things I saw in my own data was that they have really high computer penetration rates, and I learned by analyzing the data cross-nationally

that that's just as important as GDP.

It's really good to be a rich country. Your kids do better on the PISA. But it's just as important as being wealthy to have people using computers a lot. I don't think a computer's a panacea; I think probably a computer's a proxy for education matters in this country. We're all intellectuals. We think about things, and so one of my hunches about what was happening with Finland after talking to real education experts was in Finland education's free. From the very beginning at kindergarten through medical school, anybody who's willing to put the work in can go to college and to graduate school and medical school or law school in Finland. We obviously don't have that model here. I would love to see that model here. There are all kinds of political battles that would have to happen before that model could ever -- would ever reach that model, but to me that's the ideal world. Everybody who's willing to put the work in can go to any kind of school they want to go to. And so when you see nations like Finland that are outliers because they keep doing better -- their GEP's not that great; we're way wealthier than they are, but they do really well in school because I think they really value school -- and there's such an enormous value in education that they got. Some wise government person many years ago made the decision to make it truly available to everybody.

MR. FRIEDMAN: We've got a question in the front in the middle here.

MR. LORD: Thank you. Dale Lord from Senator Rockefeller's office.

I appreciated your reminder, Brett, about the inherent social nature of really the problems we're discussing here. And I wonder, you know, you hinted at the stereotypes -- if you could, and you can probably jump in, too -- the role of technology in addressing those stereotypes, of amplifying those stereotypes sometimes.

MR. PELHAM: Sure, I'll start. I mean, it's a great -- but I think part of -- one of the interesting interfaces of what's social and what's technological is it's not so cool to be a techie if you're an ethnic minority, for example. It's okay to be a geek if you're a white kid in Bethesda. You can find ways to get away with it. But there are powerful social forces that are very, very stereotype consistent -- what girls are supposed to do; what's cool if you're a black versus what's cool if you're white -- that really reinforces the status quo. And it's so pervasive that we,

ourselves -- you know, I study stereotypes and I catch myself, oh, my god, that was a stereotype. I just stereotyped that person. Was it -- oh, well, no, it was an unconscious stereotype. I don't feel quite as guilty. (Laughter) So, you know, even people why study stereotypes realize how pervasive they are and how powerful they are and how hard it is to change them.

On the other hand, we also know that one of the routes to changing them is behavior: The first, after making any changes to realize that something is true; the second set is to reorganize your life or to get involved in some kind of activity that changes that. So, for example, the stereotypes about African Americans that people show on automatic indicators that you can only get from a computer -- some of these you can only get from an fMRI -- change the minute a likeable, intelligent black guy walks in the room. So if my teacher's an African American, I have that model everyday, I'm getting primed on a daily basis to something that's counter stereotypic.

Now, I still go to the movies that afternoon. I still see that the black guys are usually the bad guys. But -- so, I still live in a social world where stereotypes are part of my experience, but I have some counter-stereotypical experience to make me think about that and challenge that a little bit.

So, it's a great question. It's a tremendous challenge, and I think technology can be used of course to reinforce the stereotypes, or it can be used in creative ways to work against the stereotypes, and we have to look for those ways of counteracting them as opposed to reinforcing them.

MR. SAXBERG: One of the great things about technology is -- you've all seen the *New Yorker* cartoon -- right? -- with the dog and typing at the keyboard? You know, on the Internet, nobody knows you're a dog, right? And, in a way, technology can be very freeing for folks who are willing to engage and, you know, have the skills to do so. There's research about things like discussion groups versus class discussions, and one of the interesting things is, you know, class discussions being so live and in the moment. Folks who actually want to think about things for a second or might not be, you know, the fastest blabbers on the planet end up getting left behind in a way, and their viewpoints are not heard. And teachers -- and I've seen it myself in

looking at classrooms, the teacher thinks the class is doing fine because 20 percent of the people have been participating, right? And so the class has been reduced to the verbal group.

With online discussions that are spaced out in time, especially asynchronous discussion boards, and especially when you have a bit of a requirement to actually post, suddenly there's no compelling reason to post quick. People who are willing to think a little bit about it and look off into space a little bit or honestly who culturally just wouldn't stick their hand up and start yammering in a room full of people with an older teacher at the front. Suddenly it's not about that at all. It's about typing my views into a screen. Now, of course, that requires tape and typing and so forth. But there is this affordance for technology to really change what it is that matters for your education and how you can become engaged. Not a panacea, because there are some who get activated by each other, and so they really want that.

But there again, technology can allow you to have the same learning objectives if they're well designed, even the same kinds of assessment tasks and then multiple different learning environments that can be determined either by you as a learner or by some diagnostics or previous history about -- learners like you seem to do really well in this kind of environment. And you will then master at high rates the same objectives as other types of learners master in other environments. And so that ability to kind of diagnose, to sort, to quickly, inexpensively provide highly reliable and differentiated learning environments I think can go a long way to helping, you know, battle against some of the stereotype issues that are there.

MR. PELHAM: That's a great concrete example. I mean, on the Internet, nobody does know if you're a dog or they don't know if you're black or white; they don't know anything about you unless you choose to reveal it. And it really does free up -- like, anyone who's taught at a university knows, especially at the level of graduate seminars, it's much more difficult, on average, to get women to speak up than to get men. I have brilliant graduate students at UCLA for 10 years, and I would give them a pep talks at the beginning of a lecture: Regardless of your agenda, regardless of your expertise in this particular area, everybody has to speak up. And there were clear gender differences.

Men, you know it's -- people call it a male answer syndrome or manspeak. Men

always have the answer. We know the answer to everything. In fact, I should study -- I've studied -- I've documented this, particularly when you threaten us, by the way. So if you point out something else I don't know, I'll become even more likely to say I have the answer, whereas women will likely -- well, maybe I don't know. So, there are gender differences that are socialized, that are stereotype consistent that are so powerful, that can go out the window if people don't know. If I don't choose to reveal my gender, I probably am not nearly so likely to succumb to those gender stereotypes.

MR. SAXBERG: I'm focusing on something completely different, which is what you want in many cases.

MR. PELHAM: Yeah.

MR. SAXBERG: Yup.

MR. PELHAM: Yeah.

MR. FRIEDMAN: So, I should add that in January we're going to have an event on exactly what people do know about you on the Internet, as a little sneak preview, but not in the educational context.

I think what we'll do is take a last few questions and sort of bash them together. So, there was one right there. Sorry.

MR. PIDEY: Thank you. Bill Pidey with Johns Hopkins University. I want to ask you a question about the infrastructures.

Whether we're talking about systems that help teachers diagnose what's -- how particular students are learning or systems of assessments or standards, we could look at these as infrastructures, and over time what we've learned about infrastructures is they get used and they end up shaping the way that certain activity happens, and I'm wondering what's the research agenda? How do we understand how these infrastructures are going to be built to support all different types of students, different ability levels? What kind of thought goes into the design of these infrastructures for different student types? And once they get deployed, how will we know whether or not they're working and for whom they're working and how?

MR. FRIEDMAN: Okay, great question.

And was there another one over here? Okay, I think -- this one, infrastructure.

MR. SAXBERG: Well, there are -- there's a long-established set of tools and methods for looking, for example, at assessments to understand how well are they working. And all of that I think applies here. It's not done as regularly to some of the formative assessment pieces, the things that teachers use every day. So one of the key things I hope comes out of, you know, the common core work -- and it sounds like it is underway -- is not just, you know, end-of-year, one-shot, record-of-failure type summit of assessments, you know. And we're still not doing it. How about that? Same as last year. Hmm. Instead, the formative assessment, so that they're within the year and frequent enough that you can actually stop and redo something, having those become validated based on looking a lot of data again and replaced if they're not working I think is a powerful part of that infrastructure.

And how will we know it works? Again, when you talk to assessment professionals, it's not one answer. You're always triangulating around these systems of standards and infrastructures. So, there's the near-term piece, which is, you know, students who do well? Do they do well on these items? There's measures of that. But I would argue there's also the longer-term piece, and sometimes that's really scary where students who appear to do well on certain of our state tests then need remedial math and remedial writing when they get to college. What is that about? I mean, that's a real failure of validity of a set of assessment tools right there. So, it's a triangulation, I think, of near-term results, then results just after the event's over, what happens next and, frankly, longer-term results. And then the feedback, too, about well, what do you wish you'd had. So, it's a triangulation exercise. And it has to apply to the individual, the microscopic assessments and standards and how they're used not just to the big one-shot every year kinds of things. And I think where technology can really help, because you can aggregate that data more quickly. You can make it be a bit more standard -- the item types and data banks of items that the teachers can take.

So, I think there's a lot there that needs to be done and hopefully with the common core things can start to become more commonplace and be worth investing in.

So, I don't know if that --

MR. PELHAM: I would totally agree with that answer, and I would add that -- you know, you asked a great question again. Great questions have many answers, but NSF is sufficiently aware of how important infrastructure is in actually assessing knowledge that for the cyber learning working group that I happen to be on right now, two of the key things they want to see is when you develop this research proposal, it's a study learning and using technology in a novel way. Is it something that everybody can use, or is it expensive and only the elite have access to it? That's a big thing they consider as part of their broader impact. Will this really help everybody?

So, if you're going to do something on Facebook, there are some people who don't have computers and you've left them out, but a lot of people have access to Facebook.

The digital pen that records what the instructor says as the instructor's talking that I can check on later, that's kind of expensive and not many people are going to have those yet. So, they pay careful attention to that, and the pay really careful attention to what are the learning outcomes, not just the traditional ones, not just SAT scores or achievement tests, but learning outcomes that are maybe, for example, more related to job outcomes. So, they pay careful attention to a multiple set of learning outcomes. And if you -- if anyone out there is doing educational research and you're planning on sending us a proposal, you'd better have multiple educational outcomes if you want to make an argument that this is going to have an educational effect. And ideally, like you said, not just at one time point but at many time points. Maybe it works pretty well for a week or two and then it has no effect whatsoever. What are the long-term consequences, too? Those are great questions that we have to answer to make progress on that sort of question.

MR. SAXBERG: One last thing on that. The assessment battle around common core is the real battle, right? What are the tasks that you mean to use to define the mastery of a brave, brief set of words, right? Because that's the thing that's going to be operationalized, is the assessment results. And so getting those tasks right unlikely to be just being multiple-choice. Otherwise, you'll just have more of the third of year grinding away on multiple-choice tests. You need some rich and complex tasks that closely match what you really intend the skill to mean,

and that's a battle royale. That's a major battle, but it's the right one to have. It's the right one to have.

MR. FRIEDMAN: All right, I think that wraps up our time, but I'd like to thank Bror and Brett and Dan who, hopefully, is okay.

And introducing the next panel on Incentives to Innovate and Encouraging Experimentation and Tech Adoption, Darrell West.