Slide One: Title Slide
As stated, my name is Dexter Fletcher and I work for the Institute for Defense Analyses. We do studies and analyses for the Office of the Secretary of Defense. We only do studies and analyses, and we produce reports that are read by tens of people. Sometimes they are read by just one person who tells us to burn the report and eat the ashes because of the answer we provide. Basically, we are expected to provide an unbiased review of scientific and technical information to inform decisions that must be made.

Slide Two: Size and Scope of Defense Education and Training
The slide tells you something about Defense education and training. It is a very large educational and training activity, perhaps the largest in history. People often think that Defense only concerns training, but there’s more to the story than that. Nobody really knows for sure how much is spent per year for education and training, because it is so difficult to separate those activities from actual operations. We also know that each year about two million uniformed and civilian personnel receive Defense education and training, about 85 percent of which has direct, non-Defense counterparts. We do know how much is spent on residential, in-place, classroom training, which is about $17 billion per year. Additionally there are about 90 thousand student-dependents in our overseas and domestic K-12 schools. And, of course, we send people off to higher levels of education in civilian colleges and universities, our own post-graduate schools, and the various command and staff colleges. Defense then covers something close to a full range of education and training activities. Accompanying all this activity, there is also, as shown in the slide, a sizable research and development program—the so-called Program Six—that may be of interest to those of us involved in education and training research.

Slide Three: ’Learning’
I will try to talk as much as I can about adult learning. Before getting to that, a point I would like to make is that education and training exist on the same continuum. In training, we assume we are preparing people for specific job tasks and objectives, -- we are preparing people to do something. Training then contrasts with education, which prepares people for their lives and overall professional careers. In training, because it is to prepare people to do something very specific, the goals are basically non-negotiable. In education, where people have an opportunity to discover what the package is that God gave them, goals may necessarily be more negotiable as individuals discover more about themselves. Accordingly then, in training we generally look at the cost to reach a certain level of effectiveness, so it involves a cost over effectiveness issue. In education, it’s just the opposite. In education, we usually have a fixed budget of time and resources, and we want to increase achievement within that budget.

Training is, therefore, a means to an end. For this reason, the military does not fundamentally want to do training; they may say they are primarily a training
organization, but what they want and need is human performance and capability in the field of operations. Education is an end in and of itself. However, there are few pure instances that are either education or training. Training usually has plenty of education in it, and vice-versa. The point here is that they appear to be simply different ends of a common dimension that we, for lack of anything better, might call learning.

Slide Four: **Technology and the Individualization Imperative**

Slide Five: **The Challenge of Classroom Instruction: Pace**

So we come to technology and the individualization imperative. If you look at classrooms and the various studies that have been done to determine how long it takes someone to learn something, you end up with ratios like these. For instance, a study on kindergarten kids found that it took some kids 13 days or 13 hours or 13 units of time to learn what some kids could learn in one, and so forth on down. Looking at these ratios, John Carroll concluded that the overall ratio of time needed to learn in K-8 classrooms was 5:1. In other words, in any classroom you are going to have some kids who are prepared to learn in one unit of time, things that will take five units of time for other kids to learn. That creates a big problem for teachers, particularly when you have 26.5 students in a classroom, which was the national average the last I looked. Most teachers aim at some middle slice of that learning speed, because you just can’t serve all the students equally give that sort of spread and limited resources. Beyond K-8 classrooms, you might wonder about an elite university, where the student population is limited to the top 90th percentile of students. I’m not going to name the university, but here is a ratio from that sort of gathering of the elite. I asked around and found a ratio of 7:1. Now, in adult education, which is where I’m dragging us, it may be even greater. The reason is that these numbers seem to be most directly related to prior knowledge. It seems to explain those differences better than anything else. I recognize that prior knowledge may not be not independent of ability, but nonetheless, prior knowledge is the most direct explanation I’ve found for these ratios.

Slide Six: **The Challenge of Classroom Instruction: Interactivity**

If you move from an examination of time to learn to levels of student engagement or classroom inactivity, you find something like this. I’ve shamelessly stolen the data in the first two columns from Art Graesser. You can see there’s a big difference in the amount of interactivity that you might measure in terms of question and answer interactions as observed in classrooms, tutorial settings, and computer-based instruction. As the slide shows, there are many more such interactions in tutorial and computer-based settings than in classrooms.

Slide Seven: **Tutoring and Classroom Instruction**

The basic issue seems to key on tutoring versus classroom instruction. The data here were not drawn from the use of technology, but solely from comparisons of one-on-one tutoring with one-on-many classroom instruction. This is Benjamin Bloom’s famous two sigma or two standard-deviation challenge. We can argue about the precise amount of difference, but it seems clear that the difference in measured achievement between students taught one-on-one and students taught in a classroom is very large.
Slide Eight: **Michael Scriven Quote**

Slide Nine: **Why Is Tutoring So Effective?**

In 1975, Scriven said that individualization was an educational imperative or an economic impossibility, and you can see why; tutoring is effective because you can individualize many things including difficulty and pace of instruction, and you can intensify the interactivity, as you’ve seen. The argument for technology is that it makes the educational imperative for individualization affordable. This is an argument I published in 1980. It was finally picked up by some folks right around 2001, so you can see how effective I’ve been in making the argument.

Slide Ten: **Enter the Computer: A Third Revolution in Learning?**

Here’s something that’s kind of fun to think about: writing, or written language, made the content of learning available anytime, anywhere, so you didn’t have to go find the relevant sage in person, in order to learn. Books made the content of learning available anytime, anywhere, and, eventually, affordable. Not only that, you didn’t have to carry around a library of big clay tablets with you. With technology, we might be at the beginning of another very serious revolution in learning, equivalent to the other two. We can now not merely capture the content, but also the interactions of successful learning environments.

Slide Eleven: **Is Technology-Based Instruction Effective?**

If we use the anytime, anywhere content and interactions provided affordably by technology, is it effective? As the slide suggests, across many comparisons of technology-based instruction with standard classroom instruction we see not just more achievement, but an achievement difference that increases with increasing sophistication in our technology-based instructional approaches.

Slide Twelve: **A Statistical Summary: The “Thirds”**

Overall when you look at hundreds of these evaluations involving technology-based learning, you find that it reduces costs by about a third. Then you get a choice, it either seems to increase learning by about a third when you hold costs and resources constant (a common education goal), or it reduces the time to achieve your instructional objectives by about a third when you hold them constant (a common training goal). The time savings seem mostly achieved by taking advantage of prior knowledge, skipping over those things that each student knows, and emphasizing those that each student does not know. Again this seems particularly important in adult learning because adults bring so much background and life experience with them.

Slide Thirteen: **Where Might We Be Headed?**
Slide Fourteen: **A Thought (or Perspective)**
Slide Fifteen: **Some Trends and a Prediction**

Here’s something I especially want to get to; where might we be headed? It is said about predictions that the future is already here, but unrecognized and unevenly distributed. Alternatively, Samuel Johnson said that the only reason for making predictions about the future is to provide amusement for the people who will live there. But undeterred, let’s look at everything that’s going on right now. We have intelligent
tutoring systems, the global information grid that we are calling the world-wide web today, natural language interaction, handheld computers, mobile phones now on steroids with games -- you can do almost anything with them including making telephone calls.

Slide Sixteen: **About Those Personal Learning Associates**
Given all this, I claim we are heading for a day when everybody is going to have their own personal learning associate, their own polymath in a pocket. The notion is that people will be finding and accessing digital objects in the world-wide web, or the global information grid because they will be portable, shareable, reusable, and accessible. We will be able to find these objects without text crawling, such as we now do with Google, because searches will tap the semantic web, which will use web services, metadata packaging, and ontologies to expose semantic linkages both obvious and non-obvious between all available objects. Much is coming along that those of us concerned with learning environments and systems will not have to build for ourselves. But what remains is for us to figure out how to assemble these objects to create effective learning environments.

Slide Seventeen: **Eventually**
Eventually we expect to have anywhere, anytime learning, which includes education and training, of course, but performance and decision aiding as well. We talk a lot about increasing the supply side of learning with more effective and efficient learning environments, but we don't talk much about decreasing the demand side of learning. One way to do that is to make sure that everybody has access to the information they need when they need it -- anytime, anywhere again. But they may not even have to learn some material in the first place because they will be able to access whatever they need to solve a problem or inform a decision online using their (wireless) personal learning associate. The second bullet (fewer lessons, more learning) mentions learning as conversation. We may learn mostly by discussing things with our personal learning associates. The slide suggest that it these will be hand-held, but they might be worn -- or even implanted, but let's put that aside for the moment. Of course, these conversations will be guided, leading to instructional objects or problem solving perhaps through the use of tutorial lessons and simulations, but the basic foundation will be provided by mixed initiative discourse in which either the learner or the personal learning associate initiates interactions. Per the third bullet on the slide, there may be more assessment, but fewer tests. Assessment will be done continuously and unobtrusively. We will learn how to do that better than we do now, but there is some good stuff going on already in classrooms and elsewhere to assess learners simply on the basis of their routine interactions or conversation, as the case may be.

Slide Eighteen: **Some Remaining Issues -- or -- Opportunities to Excel**

Slide Nineteen: **Issues for Training/Education Policy/Decision Making**
These anywhere, anytime, on-demand capabilities are going to be disruptive; let's note that. Still, we've got a little while to go before we are deep into the world of personal learning associates, but issues here are already arising. What about public policy, standards development, certification for skills and educational achievement achieved anytime, anywhere? What about budgeting and staffing? In education, we have full-time
equivalents, and in training have something called instructor contact hours. Both are based on classroom models and both are used to determine the size of budgets and staffs. How should we budget and staff for on-demand, anytime anywhere learning that occurs in classrooms and out? Will we ever be able to coordinate training and personnel functions? In our case, if people finish a training program, we may set them to painting rocks until their assignments and orders come through, which may only happen when all students in a group of cohorts finish. That's not exactly an incentive for early finishing, so it is a problem. There is also an issue of privacy. The personnel learning associates are going to know more about ourselves than we do. Who should have access to that information? How will it be protected? How will we protect and pay for intellectual property? And so forth. There's policy needed for all this.

Slide Twenty: Some Needed Research …
There are two charts here, but I think we could go on and on. How are we going to learn about learners (in education and training) and users (in performance and decision aiding) from their routine interactions? If learners are going to use these capabilities, our systems should be able to pick up information about what they know and what they don’t know, and adjust interactions accordingly. How do we do that? We don’t yet have a technology for that. Given this information, how do we assemble objects on-demand, in real time for these interactions to support either learning or performance aiding? What about verification of content? We're going to have groups collaborating to solve problems, wiki-ing and blogging away. How can we certify the correctness, validity, and/or relevance information being exchanged? How can we tell what information is viable and can be authenticated? Teachers are not going to know. As learners dig into a problem they are going to become more expert in their area than the teacher. How can teachers help learners and guide them when that happens? We also need cost models with well defined cost elements so we know what we are talking about when we report cost of learning and compare the costs of different learning approaches. We focus on doing things right -- how to make instruction effective and efficient -- but there is also Kirkpatrick’s Level 4, the matter of doing the right things. We need to develop effective procedures for determining instructional objectives. We need technology for vocational and for advocational guidance. How are we going to solve these problems for adult learners who are trying to figure out what it is they are going to do with their lives.

Side Twenty One: Some More Needed Research …
We need more research on all the design issues. I'd like to see more instructional engineering, not instruction as art or science but instruction as engineering. Where is our handbook on instructional engineering? If I have a set of objectives that an adult or any learner wants to meet, where is the handbook that tells me how to achieve them for a particular student, with a particular set of values, interests, goals, background, and so forth. There is also the business of tradeoffs within learning too. The problem here is that if you want to achieve some particular outcome, such as speed, you teach one way. If you want achieve another instructional outcome at the same time, such as accuracy, how do you train for that? How at a micro-instructional level do you trade one against the other? At the macro instructional level, how do you trade off recruiting, selection, job
classification, ergonomic design, career management, and so forth against education and training costs?

Slide Twenty Two: **In Conclusion …**
We spent some time yesterday complaining about how we can’t get anything done and effect the changes we see are needed. That was therapeutic, and I won’t take it back. For that matter, one must imagine Sisyphus happy as he struggles to get the stone up to the top of the mountain and as it rolls back. The words of Mick Jagger and Keith Richard, may occur to us all, ‘all rock and roll to me.’

(New Speaker) Wow. Well we have time for one question.

(New Speaker) Teachers trying to use Keller’s Personalized System of Instruction were upset because it was taking too long or they were getting a lot of incompletes. How does having computerized tutors help, or does it help?

(Fletcher) Well, you remember Keller’s response, what was it, 13 years later ‘Lightning Strikes Twice?’ He found that administrators were simply not willing to give the instructors the amount time they needed to give all the parallel test attempts that they would use at the beginning of the modules and at the end of the modules. We can have computers generate those tests and make them reasonably parallel because computers are so good at managing all the necessary statistics and psychometric properties. That one way we can solve this problem.

(New Speaker) Do you think that one laptop per child allows individualized learning to be provided to lower socio-economic learners?

(Fletcher) I don’t have in mind just laptops. I’m talking about a handheld or something that may be implanted in your ear, and right now there’s just a $200 price on that sort of capability, so there’s hope. I recognize that $200 is still a lot of money to some people, but Moore’s Law is still in effect and should help us here.